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EMPIRE COTTON GROWING CORPORATION

REPORTS RECEIVED FROM
EXPERIMENT STATIONS

1932-1933

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STATIONS, 1932-1933.**

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CONTENTS

	PAGE
PREFACE	v
AUSTRALIA :	
QUEENSLAND :	
BILOELA STATION	1
AFRICA :	
UNION OF SOUTH AFRICA :	
INTRODUCTORY NOTE	31
BARBERTON STATION	35
MAGUT STATION	118
SWAZILAND	135
SOUTHERN RHODESIA :	
INTRODUCTORY NOTE	149
GATOOMA STATION	150
NORTHERN RHODESIA :	
MAZABUKA STATION	159
ANGLO-EGYPTIAN SUDAN	165
UGANDA	177
NYASALAND :	
INTRODUCTORY NOTE	183
DOMIRA BAY STATION	184
NIGERIA :	
DAUDAWA SEED FARM	188
WEST INDIES :	
ST. VINCENT STATION	197
FIJI :	
SIGATOKA STATION	232

PREFACE

By J. C. WILLIS, M.A., Sc.D., F.R.S.

In accordance with the rotary scheme, the full reports this year come from South Africa (including Barberton, Natal and Swaziland), from Queensland and from St. Vincent, with summaries from the other Stations. The reports are considered in the same general way as last year, and there are also to be found throughout the reports a number of summaries and prefaces which should be read in conjunction with this general preface.

A study of the meteorological conditions given with most of the reports shows that on the whole the climates were more than usually on the unsatisfactory side—hardly anyone has a good word to say. Now, in the ordinary course of agricultural practice this is normal enough; but in conducting breeding and other experimental work it is of great importance that the work should not be interrupted or seriously damaged by a year of unfavourable conditions. It is, therefore, of great interest to read that the new Station at Domira Bay, in Nyasaland, appears to have a good cotton climate with *safe* rainfall conditions. This is a very great advantage; we found in Ceylon long ago that the irregularity of the seasons was the greatest handicap of all. Cotton, it is true, seems to stand drought better than almost any other largely cultivated crop—as the Barberton report says: “It is quite obvious that cotton is the most suitable crop they have for dry land, and a small rise in prices would see an immediate and substantial rise in the acreage planted.”

Some interesting points emerge upon a study of the climatic figures. In Uganda the climate was “abnormal all the season,” but the ultimate total of the abnormalities reacted in favour of the crop, with the result that good yields were obtained. Incidentally, most places do not seem to possess such a thing as a normal climate in any year—it is like “bogey’s” score at golf, the nearer the climate can approach to it, the more “normal” is it, and a new terminology is called for. At the seed farm in Nigeria the season began well with plenty of rain, promising good yields, but subsequently the plants became “short of moisture for the crop they carried,” there was much shedding, and the yield was poor.

It is clear that further study of the effect of climatic conditions is required, and that it will repay the work that must be expended upon it. In this connection it is of interest to note some of the physiological work that is being carried on in South Africa (page 50) to obtain figures of correlation with meteorological data. Unfortunately, these observations have been so interrupted by climate and by other things that no results are yet available, though they seem to indicate the great importance of high air and soil temperatures, which, of course, dry weather will help to secure.

In Queensland, as in South Africa, the climate was very dry, though 1932-33 seemed to be starting on the upgrade again. And, as is so often the case, the hard climatic conditions encouraged the attacks of pests, which also helped to lower the yield, while the subsoil moisture ran very low. This is an important point which has to be kept in view in the study of the best rotation crops to be employed, for some crops, otherwise good, tend to drain off too much of the subsoil moisture. From the rainfalls given on page 2 it appears that the three largest averaging 36.85 gave an average crop of 1,028 lbs., the three intermediate (28.80) one of 457, and the two lowest (19.44) one of 300 lbs. (*Cf.* note at the end of a paper by Youngman in the *Empire Cotton Growing Review*, vol. vi, 1929, p. 43, and correction on p. 206 of the same volume.)

While most cottons prefer a dry climate, this is hardly the case with Sea Island, at least for the growing season, and it is of interest to note that in St. Vincent, which produces the finest Sea Island cotton of all, the rainfall averages about 90 inches a year, and humidity 74%. The climate is described as excellent for 1930-31, with 80 inches of rain, and too wet for the other years, with 94 and 110.

Turning now to breeding of improved cottons, perhaps the most important work at the present time, it is of great interest to read the report of the three years' work at St. Vincent. During the last few years there have been complaints of the deterioration of the famous strain V.135, St. Vincent Superfine, the finest cotton in the world, though not, of course, a "bread-and-butter cotton" for daily use in every mill. The island formerly grew two sorts of Sea Island, the Superfine and the Ordinary, and there is little doubt that mixing of the strains had been going on, while some deterioration was due to the gathering of the crop at too wet a time of year. This latter has been cured by changing the date of the sowing season, and it has also been decided that, in future, the island shall only grow the Superfine; so that there only remained the problem of getting this back to, or above, its old standard. The Corporation re-opened its old Experiment

Station, putting it in charge of Mr. Evelyn, with Dr. Harland in general charge of the experimental work. The technique employed, which will repay study, is given on page 200, and the work done is outlined in the Summary on page 198, which should also be carefully read. A supply of excellent seed, enough for the whole island, is now available, and we may look to see St. Vincent Superfine take its old, if not a better, place upon the market. Details of the work are given and will be found of great interest by those who are engaged in similar tasks. Incidentally, it is interesting to notice (page 206) that a yield of 405 lbs. of lint per acre was obtained in one case, a yield which goes far to disprove the idea that V.135 is a low-yielding strain, or Sea Island a low-yielding crop.

A number of points of great interest have come out in the course of the work. See for example under Exp. 2 (page 208), the discovery that shedding, budding and bolling are to some extent hereditary; under Exp. 3 that much labour may be saved in experiments with Sea Island by giving it a red body, so that all greens may be rogued out, while, incidentally, the red body appears to be much more resistant to Angular Leaf Spot; under Exp. 4 the fact that apparently the high yield of the Montserrat Sea Island can be put into V.135; and so on.

In the summary of this work, and in Exp. 7 (page 214), will be found an account of the work on the purification and improvement of the Marie Galante and Moco strains grown on some of the other islands; also of the hybridisation work undertaken by Dr. Harland to improve the U.4 strain, work which appears promising.

The whole of the St. Vincent work appears to be a well-planned piece of breeding operations, well carried out, and we may hope for excellent results from it.

Turning now to U.4, at its headquarters, Barberton, re-selection has been going on for a number of years, and the best of the new strains promise "an increase of 10-15% over U. bulk," the cotton now mainly cultivated in South Africa. They have only to be tried in wetter years before the best all-round strain can be selected. Recent work has been devoted to getting strains capable of carrying a heavy crop during drought.

U.4 bulk has thoroughly stood the test of adverse conditions in South Africa, "and has rendered cotton-growing an economic proposition at prices which a few years ago it would have been thought quite impossible" (Milligan, page 32).

Dr. Harland has made, in Trinidad, a number of crosses with U.4 as one of the parents. Seeds have been sent out to many parts of

Africa, and may be the source of important improvement in the future ; some of them already promise well as being heavy croppers, and also tough, as well as showing good jassid resistance.

The best strains at Barberton " still cover rather a wide range in habit and general characters," and this will, no doubt, be reduced as time goes on. Safeness under very varied conditions is a very important factor to which special attention is being devoted. Notes on the more successful selections are given on page 44, and should be read together with the summary on pages 35-38.

U.4 derivatives are being experimented with in many other places ; in Swaziland most selected strains have proved higher yielders than U.4 bulk over a number of seasons, while some have proved consistently successful under all conditions experienced during the period. In Natal no definite results have yet appeared. At Domira Bay (Nyasaland) enough seed of derivatives for 1,000 acres has now been obtained, and it is hoped that in another year a very large acreage may be planted. Some strains are significantly better than U.4/2, and yields of over 800 lbs. of seed-cotton to the acre are being recorded. In Southern Rhodesia much of the commercial seed is now U.4/64, which has stood up well to a variety of conditions, and in Northern Rhodesia U.4/2 and U.4/4 proved to be better than U.4 bulk.

Uganda seems to be rather near the edge of the successful range of U.4 in Africa, as regards climate and conditions, though some strains of it were successful, and it may yet prove useful in parentage. It is fortunate, therefore, that the new cotton S.G.23/8 has proved itself to be an excellent and successful strain, which proved outstandingly superior in spinning quality to all others under trial in Uganda. It seems fairly clear that we may have in this cotton a strain which may rival in the north the success of U.4 in the south, and its authors in Uganda may be congratulated upon their work, which is of special importance from the fact that the north is a much greater producer than the south.

In the Sudan special attention was paid to Blackarm resistance, but so far with little success. In the work on Egyptian-type cottons, strains X.1530 (a selection from the Sakel main crop) and X.H.1229 (a fixed hybrid Sakel-Sea Island) are reported to have been brought to the stage of final selection for the best, both being very resistant to leaf-curl. X.1530 showed an outstanding superiority in yield, was resistant to leaf-curl, had high ginning out-turn, and competed on equal terms with Sakel in the spinning test. In the American section some South African strains did well, and also the Uganda type S.G.29.

Altogether the breeding work which is going on under the Corporation offers a record of which anyone may be proud, and while it has already saved the situation in South Africa and elsewhere, it gives promise of greater achievement in the future.

Turning now to the subject of agricultural improvement, the various reports show that the study of the improvements in the actual working of cultivation methods has been carried on as usual at most of the stations, while some, such as Queensland, have devoted the greater part of their attention to this subject. Few discoveries of general application have been made, and in most cases the results are of local applicability only, as was to be expected. Spacing experiments confirm the results already obtained in most such work, favouring the closer planting. The improvement effected in St. Vincent by changing the date of planting has already been mentioned. The chief point of general interest was the "depression" in cotton growth that followed a bare fallow. South Africa has now a definite section at Barberton for the study of physiological problems, and has devoted attention to this curious question. Both in South Africa and in Queensland it has been found that cotton grows badly in the early part of the season after a bare fallow, though it may catch up later. No solution to the question has yet been found, though it is suggested (page 78) that after a crop the land is better aerated and that the moisture has sunk in better. It is hoped to come to some conclusions during the current season.

By far the most important subject that at present falls to be considered under agricultural improvement is that of rotation of crops, to which a great deal of space, in fact one-sixth of the total, is devoted in the present reports; but as the work is of necessity primarily of local interest, and conclusions reached at any given place cannot be applied with confidence in another place, even quite near at hand, if the conditions are in any way different, we may pass over this work in a general preface with little remark. We must, however, call attention to the careful and thorough way in which the investigations are being carried on, and to some of the interesting features that come into some of the work. While the object of rotation is usually taken to be to enable the plants concerned to draw more uniformly (over the period of the rotation and in relation to the quantities present) upon the valuable agricultural constituents of the soil, many other factors and results come in. For example, in South Africa a one-year rotation has proved an effective control of the beetle *Syagrus rugifrons*, while maize everywhere proves to be specially attractive to the American bollworm, and may be used to reduce the attacks of the latter upon cotton.

Sometimes, as in Swaziland, the difficulty is with transport, the products of rotation crops being too heavy to be marketed at a distance at a reasonable cost, so that more markets if economically possible in the district, need to be opened. In some places, several crops, otherwise good in rotations, have to be omitted because they reduce the subsoil moisture too much, or because some particular class of crop must be included or must even be the only one between the cotton crops; and so on. But it is clear that the problems of rotation are being intelligently and carefully handled, and if once cotton finds its proper place in a good rotation for each district in which it is cultivated, a great step in advance will have been taken. How the rotation problem has grown in complication may be seen from the fact that not only are many direct experiments upon the actual crops being made, but breeding, spacing, manuring, time of planting and other things are also being worked at. General accounts of the work that is going on will be found in most of the reports.

Lastly, we may turn to the question of pests and diseases, which this year occupy much less space than usual, and call for less remark. The most interesting work upon them, perhaps, is that going on in South Africa, and the Rhodesias, where they fill a larger place upon the horizon of the agricultural worker than in some other parts of the Empire. As Mr. Milligan remarks in his introduction (page 34) "the necessity for a closer study of insect pests of cotton in relation to their host plants led to the establishment of a special section at the Barberton Station to deal with the subject . . . The jassid menace it is true, had been overcome, but there still remained the bollworms and the bollrot-inducing stainers." The principles upon which the section works are explained in the same report. One piece of valuable information that has already been obtained shows why maize as a trap crop needs special treatment, though it is so attractive to the bollworm, treatment for the lack of which it had largely been abandoned. Details of the work will be found on pages 102-104. Bollworm study has involved the instituting of actual records of egg-laying, parasitism, etc.; from those records information has been gained "which indicates feasible methods of crop management whereby American bollworm may be diverted from cotton." A study of parasitism on American bollworm goes to show that the local parasites are of little value, and importation is suggested (pp. 104-109).

Observations are also being carried out upon red bollworm and especially on cotton stainers and the internal boll disease carried by them. Here also careful censuses are taken under different conditions, and useful information is being collected. A study of other host plants

is also being made. In the other stations in South Africa work on similar lines is going on in co-ordination with that at Barberton.

In St. Vincent, owing, perhaps, to the change of planting season, the crops were unusually free of pests. Other colonies record various attacks of pest and disease, but few of any great severity.

QUEENSLAND

REPORT ON THE WORK OF THE COTTON RESEARCH STATION, BILOELA, FOR THE PERIOD JULY 1st, 1930, TO JUNE 30th, 1933.

BY

W. G. WELLS (Director of Cotton Culture),
L. M. HODGE (Manager) and
W. A. R. COWDRY (Field Assistant).

The three year period covered by this Report can best be described as follows :—1930–31 declining to a drought season, 1931–32 a drought season, and 1932–33 a start on the up grade to more favourable seasons. An examination of the records for 60 years of several centres situated within 20 to 80 miles of the Station indicates that the rainfall for the 1931–32 season was the lowest for the entire period. Based on these records there appears to be a general cyclic tendency wherein severe reductions in rainfall occur approximately every fourteen years, but not nearly of such intensity as in this past one. The yearly totals for the Station, along with data referring to the seasonal operations, are presented in Table I to afford an idea of the rainfall and to some extent the effect of the seasons on the yields and operations connected with growing the cotton crops since the Station has been established. The data concerning cultural operations are fairly representative of the general conditions existing in the districts where the bulk of the cotton is grown in Central Queensland, and where in recent seasons the greater part of the cotton of the State has been produced. The mean yields per acre, however, are not representative of those obtained by the average of the better farmers of the district, or of the bulk plantings on the Station. No deductions have been made for waste land for turning spaces in some of the experiments, and often the total yield obtained from an experiment was much less than would have been obtained with ordinary commercial practices.

The yields for three seasons starting with 1928–29 were also seriously lowered through corn-ear worm attacks originating from a field of lucerne in close proximity to the cotton, when a study was being made to ascertain the possibility of including this crop in the farming operations of the Valley. The yields are presented, however,

TABLE I.

Season.	Planting period.	First useful rain after germination.	Thinning period.	First killing frost.	Picking period.	Acres harvested.	Average yield per acre, (lbs. 8 c.).	Dates plants cut.	Ploughing period for next crop.	Rainfall July 1-June 30, (inches.)
1924-25	Sept. 30-Oct. 6	Oct. 20-22 (92)	Mid-Nov.	April 21	March-June	35	860	End June	July	26.51
1925-26	Sept. 18-20; Nov. 12-13.	Nov. 9-10 (145); Dec. 15-16 (131)	Early Nov.; Late Dec.	July 27-28	March-June	21.5	1,007	End June	July	32.85
1926-27	Sept. 27-Oct. 5	Dec. 13-16 (380)	Nov. 5-17	May 27	June 6-July 12	27.9	986	June 21-July 8	July 11-July 30	38.70
1927-28	Oct. 3-7; Oct. 17-20	Oct. 12-14 (111); Oct. 23-25 (311)	Nov. 3-17	May 14	April 2-June 23	31.5	1,092	July 2-9	July 9-Aug. 4	38.99
1928-29	Nov. 7-12; Dec. 6-12	Dec. 4-5 (295); Dec. 23-25 (111)	Dec. 13-Jan. 12	April 28	May 6-June 6	47	184	May 27-June 12	July 2-22	30.62
1929-30	Oct. 14-19; Nov. 13-23	Nov. 13-16 (97); Dec. 3-4 (118)	Nov. 27-Dec. 24	June 9	April 11-Aug. 1	61.5	328	July 10-25	July 11-Aug. 21	29.22
1930-31	Jan. 10-14	Jan. 27-29 (781)	Feb. 11-19	July 8-15	July 1-31	NH	NH	June 30-July 8	July 27-Aug. 8	16.16
1931-32	Dec. 12-16	Jan. 15 (115)	Jan. 11-16	June 19	May 10-18; July 4-20	47.5	121	July 8-21	July 11-Aug. 5	14.07
1932-33	Oct. 17-22; Dec. 20	Nov. 2 (67)	Nov. 11-12	June 20	Mar. 22-July 15	53	480	July	August	24.81

REMARKS REGARDING SEASONAL CONDITIONS.

1924-25.—Early rainfall light, causing shallow-rooted crop which reacted severely to mid-seasonal heat-waves. Only fair subsoil moisture all season.

1925-26.—Fair season with a tendency to produce heavy late top crop which did not open on account of no killing frosts occurring before crop cut down.

1926-27.—Lack of spring rainfall checked early development, resulting in a late-set crop.

1927-28.—An excellent season. A severe corn-ear worm attack, originating from a neighbouring farm, greatly reduced yields in one section.

1928-29.—A generally unfavourable season. Late planting, heavy mid-season rainfall causing rank growth, corn-ear worm attacks and early killing frosts.

1929-30.—Unfavourable start, but crop recovered. However, dry late season reduced yields.

1930-31.—Planting rains three months late. Favourable prospects, however, until late corn-ear worm destroyed all the crop except some progeny blocks and strain increases isolated from main cotton areas.

1931-32.—Drought—yields mostly obtained where cotton followed fodder crops or fallows of previous season.

to afford a rough indication of the effect of the variations in the climatic conditions. Fig. I is also included to present the variation in the monthly rainfall. The average yearly rainfall for the closest centre to the Research Station, Torsdale Station, is 26·69 inches* for the last 35 years. This is probably slightly lower than a record kept at the Cotton Station would have been, for Torsdale is on the inland side of it. Mount Morgan, which is the nearest station on the coastal side, averaged 32·28 inches for the same period.

It can be understood from a perusal of the table and graph, that those experiments in the last three seasons which have yielded results of any consequence have naturally been of a character pertaining to factors not seriously affected by drought, or to methods affording some measure of alleviation of such disastrous conditions as have ruled. References to the seasonal conditions and brief summaries of the most outstanding results obtained have been presented in the summarised Reports of each of the last two seasons. The present Report will, therefore, deal more with the 1932-33 season and the relation of the results obtained to similar data collected in the last two and also previous seasons.

SUMMARY.

The outstanding features of the results obtained for the period covered in the Report may be summarised as follows :—

1. A cotton crop with insufficient subsoil moisture is dependent on the occurrence of frequent rains. During dry periods at late mid-season the laden cotton crop may reduce the moisture content in the upper 12 inches of soil by 7 per cent. (based on soil dried at 100°C.) as compared with that of fallowed land.
2. Rotations and cultural methods which assist in providing supplies of subsoil moisture are therefore of value in cotton-growing, especially during dry seasons.
3. While rotations of alternate crops of cotton and fodder crops such as panicum, saccaline and maize are of value, especially in districts of low rainfall, it is possible that rotations providing fodder crops for two seasons prior to the cotton crop may give higher cotton yields. The economics of such a rotation would need careful consideration to decide if the gain in yield of cotton

* Figures kindly supplied by the Manager of the Station, Mr. Aagaard.

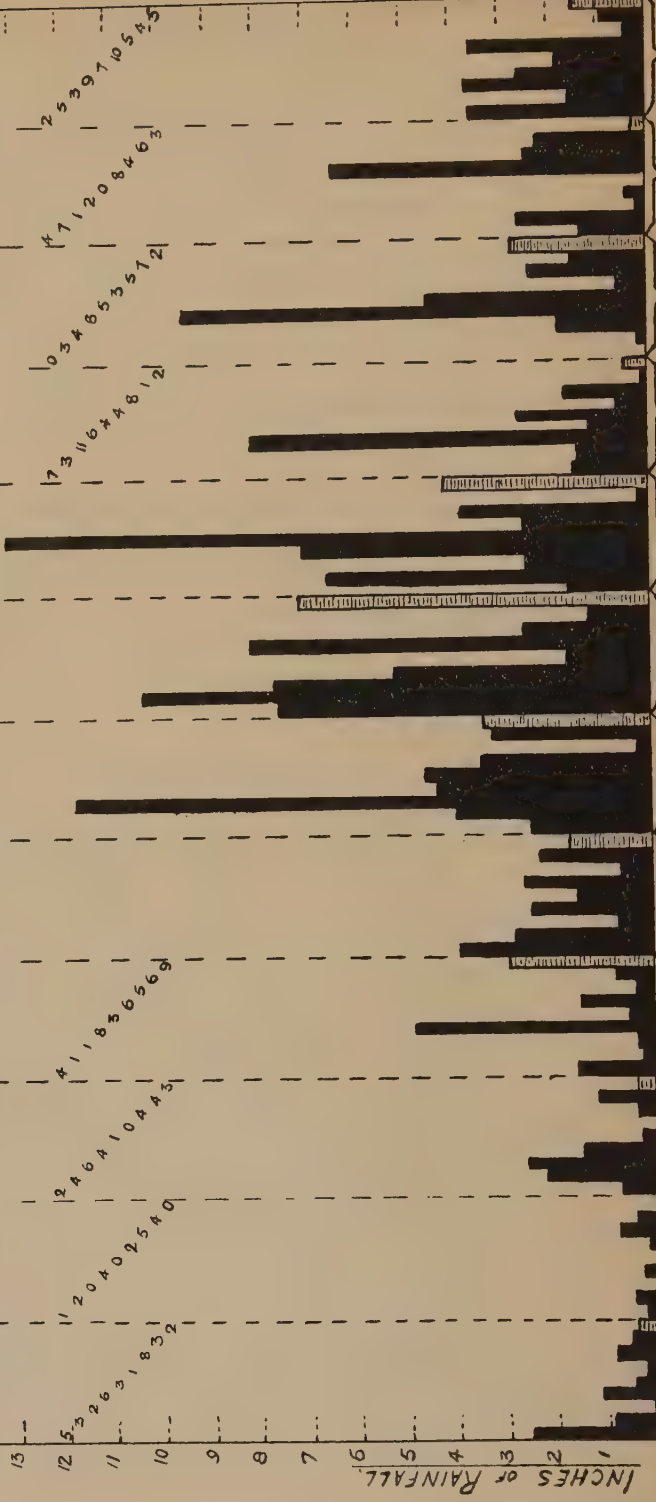
RAINFALL CHART - BILOELA.

SEASONS 1924-25 TO 1932-33.

SEASONS 1924-25
TO 1931-32 SHOWN
SEASON 1932-33

FIGURES ABOVE THE
COLUMNS EQUAL THE
NUMBER OF WET DAYS.

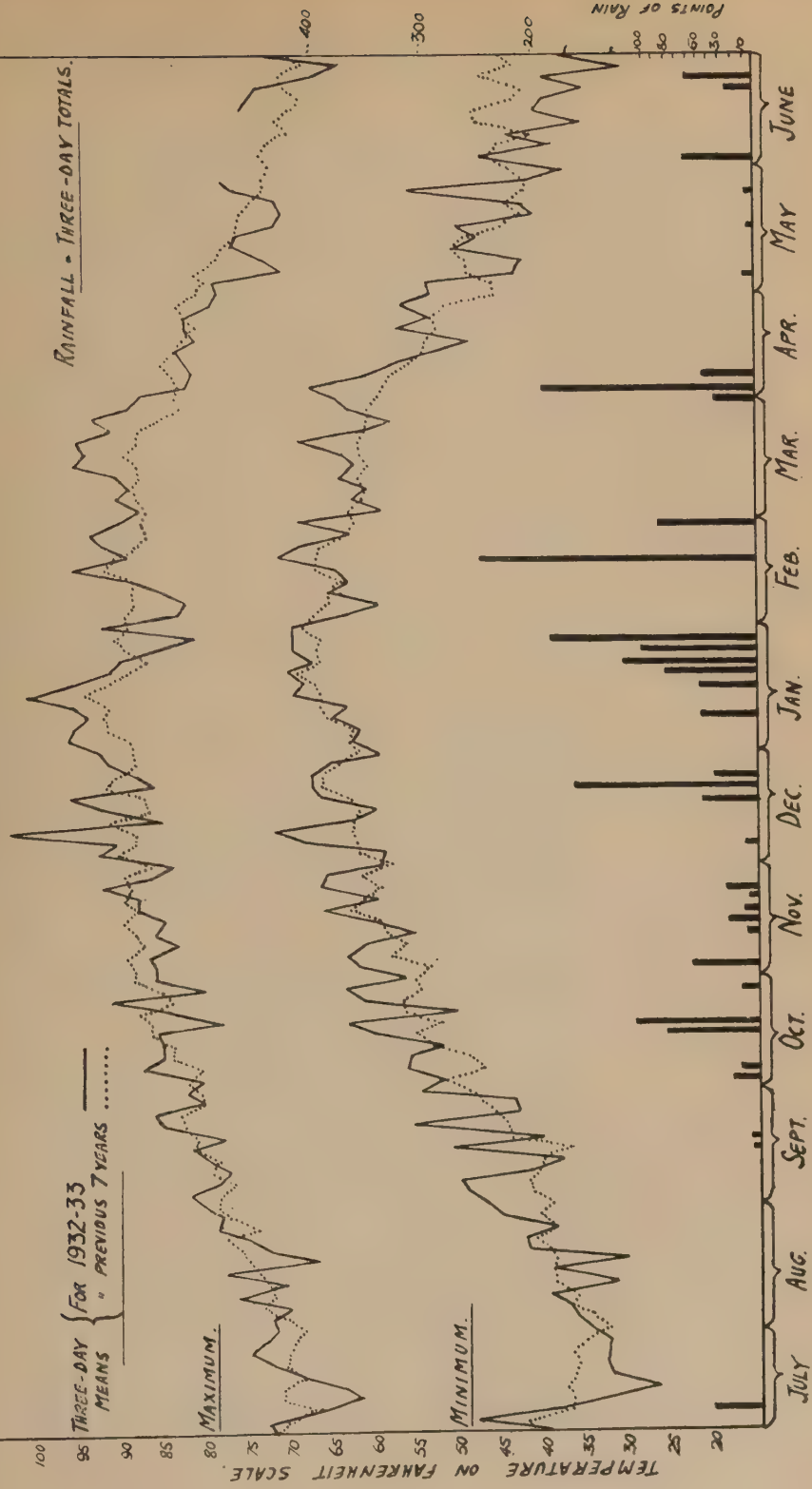
INCHES
OF RAINFALL



JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE

— RAINFALL AND TEMPERATURE GRAPH — BILOELA. —

SEASON 1932-33.



offsets any loss of revenue which might be experienced in the seasons in which other crops are grown.

4. Examinations of the root systems of cotton plants in rotations of (i) wheat, maize, cotton, (ii) cotton, cotton, and (iii) fallow, cotton, indicated no significant differences, except in the number of fibrous roots in the first four inches of soil, the plants in the cotton-cotton rotation having significantly more both in depressions and on slight slopes, and there were also significantly more such roots in the fallow-cotton than in the two fodder crop-cotton rotation.
5. During the first four years of cultivation out of the virgin state, most fertile alluvial clay loams may generally be expected to yield better cotton crops than in subsequent years.
6. Depleted organic matter, accompanied by increase of nitrates and greater imperviousness to rainfall other than gentle soaking rain, may explain the lower yields obtained on the older cultivations.
7. Examination of the root systems indicated that the plants in the old cultivations had main stalks of larger diameter both at the node of the cotyledons and 7 inches below, and also a greater number of large lateral roots. The plants in the four-year cultivation had laterals of greater diameter and more fibrous laterals in the first four inches of soil.
8. A rotation of several seasons of grass land and then three or four cotton crops may therefore be the best method of growing cotton in the dairying districts.
9. Planting delinted seed both prior to and after the planting rains, gives increased rate of germination and percentage of final stands obtained. It is not recommended, however, that delinted seed be planted before good rains occur, on account of the danger of light rains causing germination with a subsequent rotting of the seed if no further rainfall is experienced.
10. Machine thinning by the oscillating blade type of machine has consistently given more irregular stands than has hoe chopping of cotton. The plants are also left in bunches, which is an undesirable system during dry seasons, there being decided danger of not only reducing yields but also the length and strength of the fibre.

1932-33 SEASON.

While the rainfall for the season was a marked improvement on that for last season, it was not sufficient to replace the accumulated deficiency of subsoil moisture caused by the low rainfall of the previous two seasons. In addition to this, three most pronounced periods of exceptionally high temperatures occurred at critical periods in the development of the crop. Briefly, the crop might be described as having had a "hand to mouth" existence. Showers or storms occurred just in time to save it on several occasions up to the end of February, after it had got off to a reasonably fair start. Had one good thoroughly soaking rain occurred then, fairly profitable yields would have been obtained by a majority of the farmers in the adjacent districts, and most of the experiments on the Station would have given sufficient yields to have made the results fairly reliable. Unfortunately March was dry and experienced exceptionally high temperatures, the mean daily maximum being 4.3°F. higher than the mean for the previous seasons since the Station has been established. Such conditions proved very disastrous to all crops, and robbed many of the experiments of their value, particularly where cotton followed cotton. The rains of the 2nd and 5th April, totalling 2.82 inches, helped any crops which had not been too severely checked, especially in any slight depressions where the run-off of the February storms had accumulated. A top crop of squares and small bolls started developing, and under the exceptionally high minimum temperatures (daily mean 3.4°F. higher than the mean for previous years), rapid growth occurred. The first killing frost did not occur until the 19th 20th June, when the minimum temperature at grass level was 25.6°F. This terminated plant development and caused the opening of the top crop, which was surprisingly heavy in some plots.

SUBSOIL MOISTURE.

As would be expected in seasons of such low rainfall as have existed at the Station in the last three, cultural methods or cropping systems assisting in providing greater supplies of subsoil moisture have been of value to the cotton crops. Undoubtedly the cotton plant with its deep tap root system draws heavily on the subsoil moisture, and it is therefore necessary that ample supplies should be available if profitable yields are to be obtained, especially during seasons in which periods of high temperatures and no rainfall occur at critical stages in the development of the crop.

The value of such cropping systems was shown very strikingly in the season 1931 32, when in the rotation blocks cotton following

cotton averaged only 64 lbs. seed cotton per acre, while cotton following maize and panicum averaged 158 lbs. per acre. In that season all over the Station cotton following any crop without a deep penetrating tap root showed gains over adjacent cotton-following-cotton plots. Soil moisture tests on a fortnightly basis showed a markedly higher moisture content in the first 18 inches of soil where cotton followed the long fallow as compared with cotton following cotton, until the severe temperatures in January, after which the 4-6 and 10-12 inch levels in both treatments were similar. The difference in the 16-18 inch levels lasted longer, and this greater moisture in the long fallowed plots carried the crop through to much better advantage, as indicated by the above stated yields.

In the season 1932-33 gains were likewise obtained where cotton followed crops without such a tap root system, the mean yield of the cotton-cotton plots in the rotation blocks being 190 lbs. seed cotton as compared to 195 lbs. for cotton following fodder crops (one border having panicum in the previous season markedly lowered the mean). The most outstanding difference was in the wheat, maize, cotton rotation where a gain of 358 lbs. seed cotton was obtained over the mean of adjacent cotton-following-cotton plots. This would indicate that rotations may be advisable that include two crops without deep tap roots, preceding cotton, for in none of the rotations where cotton is grown in alternate years with fodder crops was such an advantage gained. Likewise the plot used for obtaining the data in the soil moisture graph failed by 153 lbs. seed cotton per acre to equal the yield of the wheat, maize, cotton rotation.

Examinations of the root system of 30 consecutive plants in a slight depression and also on a very slight slope, which were ploughed out to a depth of 7 inches, in a plot of each of the treatments (i) wheat, maize, cotton, (ii) cotton, cotton, and (iii) cotton following fallow, gave no significant differences in any of the following characters except one :—

(1) Diameter of main stalk at node of cotyledons, (2) at 7 inches below node of cotyledons, (3) number of large lateral roots, (4) diameter of lateral roots 5 inches from main stalk, (5) number of fibrous roots in the first 4 inches of soil.

In the last character, the plants in the cotton-cotton cultivation in both depression and slope had significantly more fibrous laterals than those in either of the other two treatments, indicating that with less subsoil moisture a shallow rooting system was developed with the light rains in the spring, and with the heavier January rains this system was enlarged at the expense of the development of the tap root. In all three treatments there was a tendency for the plants on the slope

to have more fibrous laterals than those in the swale, the differences in the cotton-cotton and cotton following two crops treatments being significant statistically. There were significantly more fibrous roots in the depression in the cotton-fallow treatment than in the cotton-two-crop treatment, which may indicate some nitrate depletion through growing the two fodder crops in succession.

In the season 1931-32 soil moisture tests were made fortnightly to determine the uniformity of some fallowed plots for use in the following season to study the moisture requirements of the cotton plant. No significant differences being obtained, half the border was planted to cotton and half again fallowed. Fig. III shows clearly how the cotton crops yielding at the rate of 416 lbs. seed cotton per acre used the moisture in the upper 18 inches of soil, and indicates under what a handicap the crops were grown. It is believed that had a better lower subsoil moisture existed earlier in the season less lateral root system would have been developed in the upper soils and the plants would therefore have been less dependent on frequent rains to replenish the moisture in the upper 18 inches of soil during the growing season. The determinations are being carried out in the current season, which has been marked by exceptionally heavy rainfall during the winter and planting period, in order to study the moisture requirements of the plants under more favourable growing conditions.

FALLOWING EXPERIMENT.

In the earlier years of the establishment of the Station it was noted that cotton crops following a late summer and winter fallow outyielded comparative plots where cotton followed cotton, gains of as much as 589 lbs. seed cotton per acre being obtained in 1924-25. An experiment was accordingly started in 1926-27 wherein (a) cotton followed a cotton crop of the previous season, and (b) cotton followed a fallow lasting from late summer until planting time—the fallow to be preceded by a summer fodder crop, to demonstrate the advantage that can be obtained by planting cotton after late summer and winter fallows. The results to date are shown in Table II.

TABLE II.

Crop.	1926-27.	1927-28.	1928-29.	1929-30.	1930-31.	1931-32.	1932-33.	Mean.
	lbs. per acre.	lbs. per acre.	lbs. per acre.	lbs. per acre.	lbs. per acre.	lbs. per acre.	lbs. per acre.	lbs. per acre.
Cotton-cotton	844	1422	107	449	nil.	51	254	521
Fallow-cotton	787	1176	73	969	nil.	111	227	557
Difference ...	57	246	34	-520		-60	27	-36

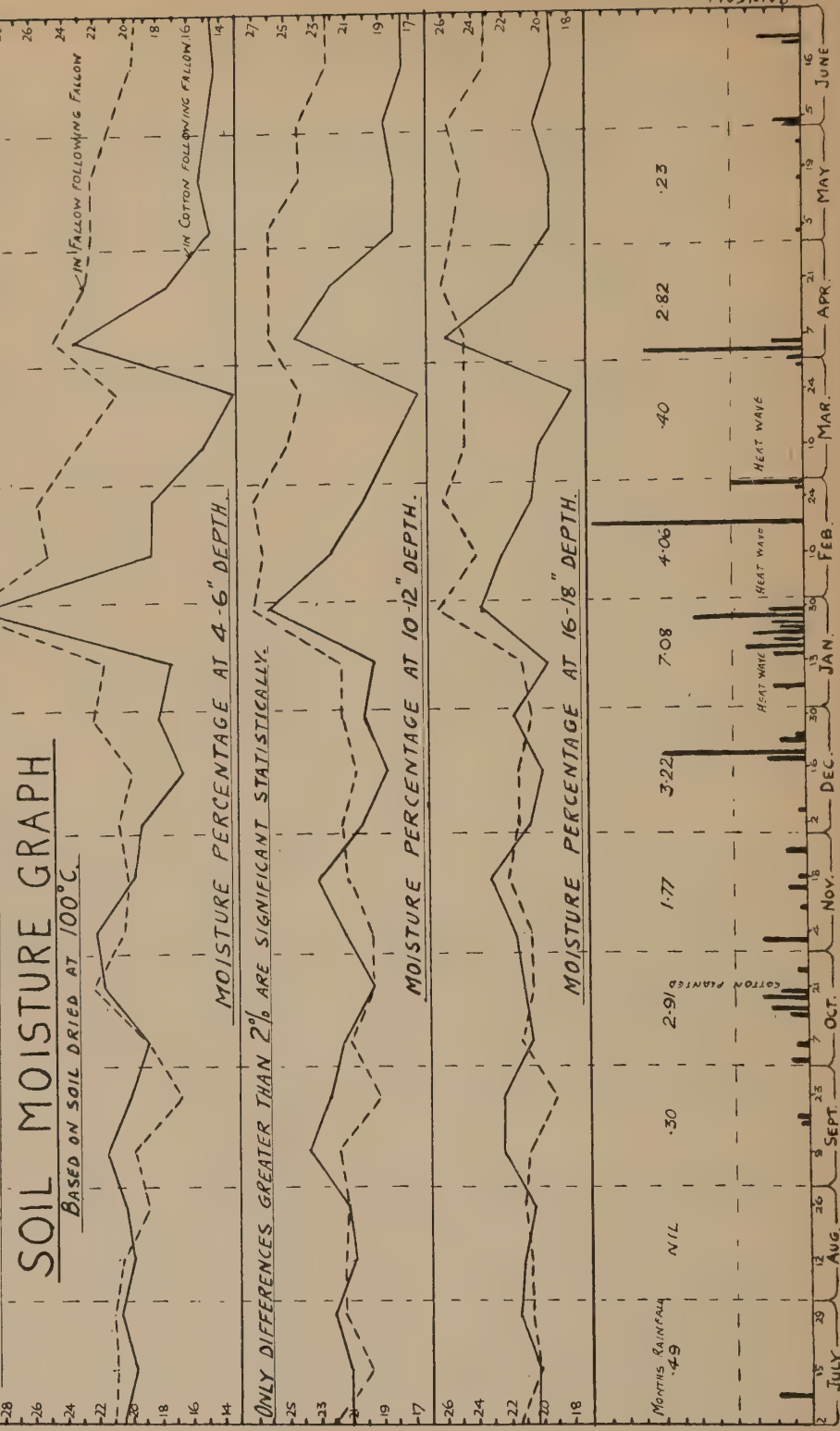
Seasonal Notes.

1926-27, much heavier bottom crop in cotton following fallow than in cotton-cotton. Late rank growth caused the destruction of much of this through boll rots.

ILLUSTRATING DRAIN ON SUBSOIL MOISTURE BY COTTON CROP 1932-33.

SOIL MOISTURE GRAPH

BASED ON SOIL DRIED AT 100°C.



ONLY DIFFERENCES GREATER THAN 2% ARE SIGNIFICANT STATISTICALLY.

MOISTURE PERCENTAGE AT 4-6" DEPTH.

MOISTURE PERCENTAGE AT 10-12" DEPTH.

MOISTURE PERCENTAGE AT 16-18" DEPTH.

MONTHLY RAINFALL

RAINFALL

Scale - 1/16" = .25 points

RAINFALL

1927-28. Best season Station has experienced. Poorer stands in cotton-fallow treatment may account for difference. A comparable adjacent rotation gave only slight gain in favour of cotton-cotton.

1928-29. Very rank growth, crop obtained mostly from open spaces caused by gappy stands in cotton-cotton.

1929-30. Cotton following fallow undoubtedly of advantage on account of very light spring rainfall.

1930-31. Very late planting which was destroyed in late season by severe corn-ear worm attack.

1931-32. Drought year, cotton following fallow of marked advantage and much greater gain would have been obtained had sufficient mid-seasonal rain been experienced to fill out bolls borne in this treatment.

1932-33. No increase in subsoil moisture was obtained in the summer crop fallow treatment.

A mean gain of 36 lbs. seed cotton per acre per year for the six years in which yields were produced has been obtained in favour of the cotton following fallow after summer crop treatment. This was mostly contributed by the increase obtained in 1929-30 when the cotton following cotton treatment had to be replanted on account of loss of stand through drought and wire worm damage. The gains obtained are not significant statistically, and are not in keeping with what was anticipated. Severe losses resulting from heavy migrations of corn-ear worms from an adjacent lucerne field in three of the seasons may have affected the experiments so much as to upset the relative merits of the treatments. It is possible also that giant panicum may not be the best crop for such a rotation. It was selected on account of the rapidity with which it could make a profitable growth of good quality hay, the less likelihood of a crop failure as compared with maize, and also because it was thought that panicum would deplete the nitrates in the upper soils to better advantage as the crop would be cut for hay, and that the stubble would supply sufficient organic matter to maintain a suitable physical condition of the seed bed and yet not make it of too open a nature. The plots in the rotation series in which cotton followed maize show an annual mean gain of 18.3 lbs. seed cotton per acre over those where cotton followed panicum. It is possible, therefore, that using maize in the fallowing experiment would give greater gains in favour of the fallow following a summer crop. Root examinations, similar to those already described, indicated a significantly greater number of fibrous lateral roots on the slopes where cotton followed panicum as compared with cotton following maize, the number being slightly greater than where cotton followed cotton. There was no significant difference in the depressions, although the number was greater in the plots where cotton and panicum had been grown previously. Likewise, the panicum-cotton treatment had a significantly larger number of fibrous laterals than that in which cotton followed a long fallow. It is pointed out, however, that only 14.07 inches of rain fell in the 1931-32 season, and that both the panicum and maize were practically failures. The panicum certainly influenced the subsoil moisture, however, for this season is the first in which the soil moisture determinations have not shown significant

differences in the early part of the season at all levels, in favour of the fodder crop—short fallow treatment. Nevertheless, it is questionable if maize, except on the best of the alluvial soils in the Valley, would be of equal value to the farmers, who mostly combine dairying with cotton-growing.

It would appear, therefore, that over a long series of seasons cotton following some form of fodder crop, which is taken off in time to allow the land to be ploughed before the June rains occur, may be expected to yield some increase over a cotton-following-cotton rotation. In very dry seasons larger gains will be obtained than in more favourable ones. It is possible that even greater gains will be obtained where cotton follows two seasons of fodder crops.

NEW CULTIVATION EFFECT.

A demonstration of the benefit which may be gained through planting cotton on new cultivation just out of the virgin state was again obtained this season. Additional areas were brought under cultivation in three of the blocks of plots on the Station. In two out of three of the blocks low yields have been obtained during the last few seasons. In the third, which is of a heavier clay loam type and of lower nitrate content, average yields have been usually obtained on the portion nearest the new cultivation brought in this season. In the two blocks where the low yields have been obtained of late, new cultivation was added in 1929–30, and yields of 865 compared with 588 lbs. seed cotton per acre in J. block, and 1,460 compared with 684 lbs. in K. block were obtained in favour of the new cultivation. This season the following yields were obtained for the eight-year old, the four-year old, and the new cultivations :—

TABLE III.

				<i>New cultivation.</i>	<i>4-year old.</i>	<i>8-year old.</i>
				lbs. per acre.	lbs. per acre.	lbs. per acre.
J	...	...	...	891 (a)	—	883 (b)
K	...	...	...	917 (b)	501 (b)	251 (d)
K	...	...	...	1171 (c)	475 (c)	436 (c)

(a)=Mean of four 1-acre plots ; (b)=Mean of two 1-acre plots ; (c)=Mean of two half-acre plots ; (d)=Calculated yields from 12 Durango plots in variety tests, in order to have one variety common to all blocks.

The growth of the plants in J. and K. blocks was typical of the results usually obtained on the Station and generally in commercial crops where the comparison of crops on new and old cultivation has been possible.

The plants on the old country made a very rank, sappy growth with every indication of more than ample supplies of nitrogen, and bore only light crops on the bottom fruiting branches and over the very upper portions on the fruiting branches of the vegetative branches. The terminals were frequently lost—59 per cent. in the Durango plots in the varietal tests nearest to the new country—and on plants without

terminals only a top crop of bolls was borne on the fruiting branches towards the ends of the vegetative branches. The crops on the four-year old country were of much more open type, with reddish coloured stalks and vegetative branches, while the leaves were smaller and of a light yellowish green and of tougher tissue. A much smaller loss of terminals occurred on the new country, four rows in I. block totalling 1,466 plants gave a terminal loss of 46 per cent. as compared with 72 per cent. of 1,243 plants in four rows on the old country in I. block. This is a most important difference, for on the old country the early loss of a terminal sets back the fruiting of the plant at least a month, while the vegetative branches are developing sufficiently to carry fruiting branches. The loss of terminal on the new country is not so serious, for the vegetative branches develop fruiting branches at lower nodes than is the case with the plants on the old country.

The explanation of this difference in growth on the old and new country is not clear. It would appear to be excessive nitrates in the case of many cotton crops which have been studied both on the Station and on farms in the district. Observations made this season following heavy storms tend to show that possibly the physical condition of the soils may also play a part in the results. It has been noted that much better penetration of storms occurs in the new country, it being possible to walk in the crops with comfort in a couple of days, whereas in the old country the slightest depressions stay boggy for several days, and it was also noted that the least slope dried very quickly even with a heavy downfall.

Certainly cultivation over a series of seasons brings about some adverse conditions in the soils, as instanced this season in the new cultivations in J. and K. blocks. The first five rows of the new cultivation plots were actually on a roadway or headland of the four-year old cultivation. This land had been kept in bare fallow of good tilth for four seasons, and had not been used as a roadway sufficiently to pack it underneath. The plants in these five rows grew more rankly than those in the adjacent four-year old cultivation, and much more so than those in the new cultivation. Table IV shows the yields obtained in the five rows in the old roadway as compared with the adjacent five rows in the four-year and new cultivations.

TABLE IV.

<i>Total yields of 5 rows in each.</i>	<i>1st pick.</i>	<i>2nd pick.</i>	<i>Total.</i>	<i>% 1st pick of total.</i>	<i>Yields in % of 4 year.</i>
	<i>lbs. s/c.</i>				
4-year cultivation, J.12 and K.12 ...	264		264	100	
Roadway, J.13 and K.13	306.5	138	444.5	68.9	168.3
Adjacent new cultivation, J.13 and K.13	356	157.5	513.5	69.3	194.5

An examination of the root systems of plants on the eight-year old, four-year old and new country at comparable sites was made, the plants being ploughed out at a depth of seven inches and data collected from thirty consecutive root systems at two different places in the row in each treatment, one set of 30 consisting of taller plants than the other set.

Table V records the results obtained.

TABLE V.

<i>Character.</i>	<i>Order of magnitude, the first type being the largest.</i>	<i>Differences which were significant statistically.</i>
Diameter of main stalk at node of cotyledons.	8-yr., 4-yr., new.	8-yr. compared with 4-yr.; 8-yr. compared with new.
Diameter of root 7 in. below node of cotyledons.	8-yr., 4-yr., new.	8-yr. compared with 4-yr.; 8-yr. compared with new.
No. of large lateral roots. (On one site where the plants were slightly shorter no significant differences, although the order of magnitude was similar to that of the larger plants.)	8-yr., 4-yr., new.	8-yr. compared with 4-yr.; 8-yr. compared with new.
Diameter of lateral roots 5 in. from main stalk.	4-yr., new, 8-yr.	4-yr. compared with 8-yr.; New compared with 8-yr. (taller plants).
	4-yr., 8-yr., new.	4-yr. compared with new (shorter plants).
No. of fibrous lateral roots in first four inches of soil	4-yr., new, 8-yr.	4-yr. compared with new; 4-yr. compared with 8-yr. (tall plants).
	4-yr., 8-yr., new.	4-yr. compared with new; 4-yr. compared with 8-yr. (shorter plants).

It would appear from the data, that the main stalks of plants on the eight-year old cultivation were of greater diameter both at the node of the cotyledons and seven inches below them; that there were more large lateral roots which were smaller than those in the other soil types; and that there were fewer fibrous laterals in the first four inches of soil. The plants in the eight-year old cultivation tended also to be larger, but bore much less crop. The diameters of the lateral roots and the numbers of fibrous laterals were greater in the four-year old cultivation than in the other two treatments. It is possible, therefore, that there being less nitrates in the new country and more organic matter and therefore better penetration during the heavy January rains, the plants developed a deeper root system, which carried the crop through heat waves and stress conditions to better advantage. The plants in the eight-year old country on the other hand, with less subsoil moisture, less organic matter (determinations of total carbon content indicated significantly less than in either four-year old or new country) and more nitrates, made more lateral roots and therefore were more dependent on frequent rains. When these occurred the greater lateral root system absorbed the nitrates, which were possibly more available than in the new country in which there were large amounts of grass roots, etc.

A comprehensive series of long range experiments dealing with soil moisture, nitrate content, total carbon content and varietal responses have been laid down to start in the 1933-34 season; it is hoped that these will throw further light on this problem, which appears to be of major importance for cotton-growing on much of the alluvial soils of the State. The results of investigations carried out so far indicate that where cotton is grown in fertile alluvial soils, better returns can be expected on the newer cultivations than on the older ones. It is possible, therefore, that a rotation of several years of grass land followed by three or four cotton crops may be the most profitable one for most of the districts of the State where cotton-growing and dairying are carried out on the same farm.

METHOD OF PLANTING.

With such light rainfall as frequently occurs in the earlier planting months in most of the cotton-growing districts, any method of planting which hastens a good strike is of value, provided subsoil moisture is available. Prior to the last two seasons, experiments in methods of planting have shown that planting soaked seed gives a gain of at least 24 to 36 hours in obtaining a strike showing above ground. With the installation of delinting machinery at the ginneries for supplying seed for scrub plantings, it has been advisable to test the method of planting delinted seed in the cultivated soils. Accordingly, in 1931-32 the following experiment was started:—

- A. Undelinted seed planted in the dry soil prior to planting rains.
- B. Undelinted seed planted following the planting rains.
- C. Soaked, undelinted seed planted following the planting rains.
- D. Delinted seed planted following the planting rains.

The dry planting was made on 23rd September and did not complete germination until near the end of November, the rainfall of that month being 2.17 inches in the form of scattered light showers. Considerable dying off occurred continuously through the dry weather until the planting rains of mid-December. The rest of the plantings were made following these, and Table VI shows the relative rate of increase of germination obtained in them.

TABLE VI.

<i>Treatment.</i>	18.12.31.	19.12.31.	<i>In-crease.</i>	20.12.31.	<i>In-crease.</i>	21.12.31.	<i>In-crease.</i>	22.12.31.	<i>In-crease.</i>
Ordinary undelinted	66	304	238	332	28	390	58	405	15
Ordinary delinted	156	398	242	444	46	500	56	510	10
Ordinary wet undelinted	223	413	190	461	48	492	31	507	15

With the continuance of dry hot weather further dying off occurred in all treatments, although counts indicated that the delinted treatment had lost the most and ordinary undelinted the least. Apparently there was such a premium on soil moisture that the treatment with the thickest stand lost most heavily under the severe conditions. When the thinning to 2 ft. single plants was completed, counts of stand remaining were made; while not giving significant differences, they indicated that the undelinted, dry-planted seed had consistently the poorest stand, with the soaked seed slightly ahead of the other two treatments.

The experiment was planted partly on fallowed land and partly on land in cotton in the previous season. Owing to the drought, the portion on the cotton-cotton land failed, so no information could be obtained as to the value of the different methods on such land. There were three repetitions of the plantings on the fallowed land, and although the actual yields obtained were in favour of the delinted seed sown after the planting rains, the results were not significant statistically.

In the 1932-33 season, the same methods of planting were again tried, and in addition delinted seed planted in the dry prior to planting rains was included on account of the tendency to use this method in the general commercial plantings. Counts made in forty randomized 2 ft. lengths of row gave data as shown in Table VII.

TABLE VII.

Method.	23.10.32.	24.10.32.	25.10.32.	26.10.32.	27.10.32.	28.10.32.	Stand on 25th ex- pressed as % of 28th.	17.11.32. X	Y.
A. Unde- linted, planted 19.9.32	106	129	130	132	133	139 ⁽⁴⁾	94	132	87.8
B. De- linted, planted 19.9.32	297	316	338	334 ⁽⁴⁾	334 ⁽⁵⁾	337 ⁽¹²⁾	100	318	99.9
C. Unde- linted, planted 19.10.32	—	—	59	96	106	105	56	143	95.4
D. Soaked unde- linted, planted 19.10.32	—	—	82	114	119 ⁽⁵⁾	114 ⁽⁵⁾	72	132	95.4
E. De- linted, planted 19.10.33	—	—	184	204	211 ⁽⁵⁾	209 ⁽⁷⁾	88	245	94.9

Figures in brackets indicate "died off," presumably from heat and dry conditions.

X = Final seedling stand prior to thinning.

Y = Final stand after thinning to 2 ft. singles, expressed as % of perfect stand.

It will be seen that the dry-planted seed came away much earlier, especially the delinted seed, which was also the earliest in the sowings

after the planting rain. Both methods of planting delinted seed gave better stands than did any of those in which undelinted seed was used. This may have been due to some extent to there being more seed per lb. of the delinted seed, but as the delinted always gives better and quicker rate of germination it is not believed that the number of seeds per lb. was the sole factor involved. The final stand of plants perfectly spaced 2 ft. apart was the lowest in the undelinted dry planting and the highest in the delinted dry planting, although all yielded good commercial spacings.

Unfortunately an unusual outbreak of some form of wilt occurred in this experiment, which affected the plants so badly as to cause the yields to be of little value. No thoroughly representative results have therefore been obtained from the experiment for the last two seasons, to demonstrate the value of obtaining a stand in the quickest manner. It is believed, however, that sowing delinted seed after the planting rain occurs has marked advantage over other methods. A stand is obtained more quickly and at a heavier rate with the delinted seed, and where sufficient subsoil moisture exists, this should be of considerable value, especially in springs of light rainfall. As the delinted seed planted dry was the quickest to obtain a full strike after the planting rain in 1932-33 season, it is possible that sowing soaked delinted seed after the planting rain is the most advisable method of obtaining a quick strike. There may be some disadvantage in obtaining a heavy strike quickly in some seasons, especially where the subsoil moisture is deficient. Planting rates of 12 to 15 lbs. delinted seed and early thinning should help to overcome this difficulty.

HOE VERSUS MACHINE THINNING.

Thinning is the only operation for which the average grower with a large acreage has to employ labour, with the exception of picking. As the cost per acre is rather high, a grower with a large acreage has to expend an appreciable sum of money, and if a suitable machine could be found which would allow the grower or his family to do all the work, it would be of marked value to the industry. It has to be pointed out, however, that not only has the machine to do the thinning efficiently, but the spacing of the plants has to be such as not to reduce the yields or quality compared with those obtainable from hoe thinned crops.

An experiment has accordingly been carried out for several seasons to ascertain the merits of a machine of the oscillating cutting blade type made by the Bucher and Gibbs Plow Company, Ohio, U.S.A. Blades 6 and 9 inches long have both been tried in comparison with

2-ft. hoe-spaced single plants. Unfortunately the seasonal conditions have been so unsuitable for cotton that results of little value as regards yields have been obtained up to this season. Careful observations have been made of the spacings obtained, and of their effect on plant growth. Up to date no differences in favour of machine thinning have been obtained.

One of the outstanding drawbacks of the machine has been the gappiness of final stand obtained with it and the bunching of the plants left. Table VIII records the results obtained in 1931-32, the counts being taken in twelve randomized 10-ft. lengths of row in each treatment. Planting rate, 25 lbs. undelinted seed per acre.

TABLE VIII.

Gaps.	HOE.				MACHINE.			
	Before.		After.		Before.		After.	
	No.	%	No.	%	No.	%	No.	%
Gaps of 6" ...	107	68.6	—	—	100	67.5	10	16.6
" " 12" ...	34	21.8	—	—	34	23.0	18	30.0
" " 18" ...	8	5.2	13	23.6	12	8.1	10	16.6
" " 24" ...	3	1.9	31	56.4	—	—	8	13.3
" " 30" ...	2	1.4	7	12.9	1	.7	3	5.0
" " 36" ...	1	.6	—	—	1	.7	2	3.5
" greater than 36" ...	1	.6	4	7.1	—	—	9	15.0

In this past season the experiment was again carried out by the "Student" method, using the 9-inch blade. Planting was at the rate of 25 lbs. delinted Durango seed per acre. Population counts of 24 randomized six-foot strips for each treatment gave the results recorded in Table IX. Thinning was performed when the plants were 6 inches high.

TABLE IX.

Gaps.	HOE.				MACHINE.			
	Before.		After.		Before.		After.	
	No.	%	No.	%	No.	%	No.	%
Less than 6 in. ...	207	90.4	—	—	210	92.9	31	35.2
Less than 12 in., more than 6 in.	22	9.6	1	2.5	12	5.3	36	40.9
Less than 18 in., more than 12 in.	—	—	9	19.0	4	1.8	7	7.9
Less than 24 in., more than 18 in.	—	—	35	71.0	—	—	6	6.9
Less than 30 in., more than 24 in.	—	—	4	8.5	—	—	3	3.4
More than 30 in. ...	—	—	—	—	—	—	5	5.7

A very uniform strike of seedlings was obtained throughout the experiment and the thinning results obtained should be indicative of the efficiency of the machine, for the condition of the seed bed and the stand were entirely satisfactory. It will be noted that although the spacing was variable, 76% of the stand left by the machine was spaced

12 inches or less. As bunches of plants were frequently left, the resultant plant population was unsuitable for a season of the nature experienced. Table X records the yields obtained :

TABLE X.

									Mean.	
	Machine.	Hoe.	Hoe.	Machine.	Machine.	Hoe.	Hoe.	Machine.	Machine.	Hoe.
Yields lbs. s/c per acre Plots $\frac{1}{18}$ acre.	330	457.5	528.75	270	258.75	408.75	510	491.2	337.5	476.2

Difference in favour of hoe-thinning 138.75 lbs. seed cotton per acre. Odds Z significant 28 to 1.

Sixty systematically located plants in the hoe thinning were picked separately, and at the same location in the comparative plot a hill of the machine thinned was picked. The only significant differences obtained were length and strength of fibre, in which the hoe thinning was substantially superior to the machine thinning.

In addition to this examination, a row from each plot of each treatment was harvested by one picker for a study of the grade of the cotton. Table XI indicates the results obtained :—

TABLE XI.

Spacing.	Machine.	Hoe.	Hoe.	Machine.	Machine.	Hoe.	Hoe.	Machine.
Length ...	1" full	1 $\frac{1}{8}$ "	1 $\frac{1}{8}$ "	1 $\frac{1}{8}$ "	1"	1 $\frac{1}{8}$ "	1 $\frac{1}{8}$ "	1" full.
Grade ...	Low side	Top side	Wasty	Low side	Wasty	Wasty	Wasty	Low side
Character	S. MID.	S. MID.	MID.	S. MID.	MID.	MID.	MID.	S. MID.
		All		soft.				

The grade would appear to be slightly better in the machine thinned, possibly due to the smaller and less vegetative plants.

It would appear, therefore, that no advantage would have been obtained this season by machine thinning on soils similar to those on which the experiment was conducted, for the difference in favour of hoe thinning would outweigh several times any reduction in the cost of thinning that might be effected. The experiment is being continued over a series of seasons, however, in order to obtain more comprehensive evidence as to the relative merits of machine thinning.

VARIETAL TESTING.

The expansion of the cotton spinning industry in Australia and the tendency to produce a greater percentage of the lower counts of yarns needing shorter and harder bodied cotton than the industry required in the earlier years, has necessitated an investigation into a wider range of varieties than had been studied previously. In connection with varietal tests and pure seed plots carried out in the

main districts, studies are being conducted at the Station of all the most important varieties being tested. The seasonal conditions during the past two crops in which varietal tests have been carried out have seriously affected the results obtained, and the experiments have not been thoroughly indicative of the true merits of the varieties, especially as soil irregularities, presumably caused by the droughty conditions, have obviously influenced plant growth. Detailed data on many points are therefore lacking and general observations on the relative merits of the varieties have had to be used regarding several important features.

Season 1931-32.—The experiments in 1931-32 were divided into comparisons of Durango (*a*) with the small and medium sized boll varieties, Delfos, Trice, D. & P.L. 4-8, Coker Super 7, and Lightning Express ; (*b*) with the large sized boll varieties, Lone Star, Mebane, Rowden, Miller, Wacona and Acala ; and (*c*) with Lone Star 65, a medium boll type. While no significant results were obtained regarding yields, the actual records placed only Delfos ahead of Durango in the small boll experiment, and Durango ahead in the big boll types, although only slightly better than Lone Star 65. Flower counts on 300 plants of each variety, while giving a very low mean number of flowers per plant, were in the same order as the yields, in that Delfos had the highest mean number, Durango second highest in the small to medium boll test, and Durango the highest and Lone Star 65 the next highest in the large boll test. The graphs of the flower counts showed very clearly the marked superiority of the Delfos variety as regards earliness of flowering after a severe cessation in mid-March. Towards the latter part of the season Durango outflowered all varieties in all tests. In the medium to big boll types, Lone Star 65 flowered decidedly more heavily prior to the cessation of flowering in mid-March, but Durango recovered the best after that. As the cessation of flowering was the result of an attack of corn-ear worm and rough boll worm, the ability of the Durango to recover the quickest is of marked advantage, for such attacks are likely to be experienced in any season.

Counts of the total number of fruiting nodes on 60 plants in each variety at mid-January, mid-February and mid-March indicated clearly the superiority of Delfos for cropping possibilities, and the heavier setting of "forms" of Delfos and Trice at the last count. Durango lost the highest percentage of forms by mid-February, but recovered by mid-March, being the third lowest. Similar counts in the big boll test indicated that, at the last date, Durango had the highest number of crop possibilities and the most forms set, Lone Star 65 being just slightly inferior. Lone Star 65 was markedly in the lead in both

characters at mid-February, showing that it is a quicker fruiting variety than Durango or the big boll types, but Durango, with a better fruiting system on the vegetative branches and more of them, recovered in the latter part of the season to better advantage.

The experiments, while presenting very limited information, would appear to indicate that Delfos and Lone Star 65 may yield better than Durango on the rich alluvial loams of the Callide Valley. Delfos has a very small boll, however, is of low lint percentage, and requires very uniform climatic conditions to produce fibre of good quality. Lone Star 65 is undoubtedly a promising variety, but tends to produce weak lint under adverse conditions. It has a higher lint percentage than Durango and a fibre length of 1 to $1\frac{1}{16}$ inches; it would, therefore, be a suitable cotton if strains with sufficient ability to withstand severe climatic conditions can be developed. As none of the small balled, quick maturing types tried gave better results than Durango, it would appear that possibly the early maturing, either medium or big boll, drought-resisting types of high lint percentage would offer the most likely field for investigation in an endeavour to find a superior cotton to this variety.

Season 1932-33.—Owing to the very adverse conditions of the previous season the varieties were tested again, excepting Rowden, which had given such poor results that Indio Acala was substituted, and in addition Mis Del No. 1 and No. 2 were also tried.

Confirmation of the findings of the previous season was obtained, which indicated that the varieties with medium sized, thin to medium fuzzed seed germinated the quickest. Mebane and Miller, two large seeded, heavily fuzzed varieties, were very slow in germinating in both seasons, as was Indio Acala in the second season. Lone Star, which is a big seeded type, however, was only slightly behind Durango, which was the best of the medium to big boll types in both seasons. Coker Super 7 was the quickest to germinate of all varieties in both seasons.

Counts made at 50 days after germination in the first season and at 34 days in the second, failed to indicate any significant differences in the percentage of lost terminals. Wacona gave slight indications in both seasons of being less susceptible to terminal loss. Indio Acala was significantly less attacked than either Durango or Miller, the comparative varieties of the test, up to 34 days after germination, but by mid-season it was the worst of the three.

Flower counts were again made on 300 plants of each variety and gave clear evidence of the heavier flowering capabilities of some of the small to medium balled types. The mean number of flowers per plant for each variety is shown in Table XII.

TABLE XII.

<i>Small to med. boll type Expt. No. 1.</i>		<i>Small to med. boll type Expt. No. 2.</i>		<i>Medium to large boll type Expt. No. 3.</i>		<i>Medium to large boll type Expt. No. 4.</i>	
<i>Variety.</i>	<i>No. of flowers.</i>	<i>Variety.</i>	<i>No. of flowers.</i>	<i>Variety.</i>	<i>No. of flowers.</i>	<i>Variety.</i>	<i>No. of flowers.</i>
Delfos	17.04	Mis Del 1.	25.01	Lone Star 65	16.15	Durango	12.42
Trice	15.21	Mis Del 2.	23.77	Durango	10.73	Indio Acala	9.68
DPL 4-8	11.71	Durango	16.40	Wacona	10.33	Miller	8.29
Coker 7.	10.56			Acala	9.55		
Durango	10.30			Lone Star	7.68		
L. Express	9.59			Mebane	6.73		

The outstanding features of the flowering graphs was the superiority of Delfos throughout practically the whole season in Experiment No. 1, Durango being unaccountably low all through the latter half; this is contradictory to last season's observations and to the manner in which the variety usually flowers. In Experiment No. 2, Mis Del No. 1 was the best and was substantially ahead until after February, when Mis Del No. 2 was superior, with Durango flowering the best at the end of March. Lone Star 65 was outstandingly ahead in Experiment No. 3 after the first three weeks of counting until mid-March, after which Durango led. Wacona again showed marked earliness of flowering for a big boll type, but, similarly to last season, this variety flowered lightly after the mid-season cessation. Durango was clearly ahead all through the season in Experiment No. 4.

Cropping possibilities were also taken at mid-December and mid-February. Owing to the large vegetative growth of the plants and pressure of other work, it was not possible to take the mid-March count to compare with last season. The experiments may be summarized as follows:—

Experiment 1. Durango ahead in possibilities, but next to last in forms set at mid-February.

Experiment 2. Mis Del No. 2 ahead in possibilities and forms set.

Experiment 3. Durango ahead of Lone Star 65, and both decidedly ahead of all others in possibilities and forms set.

Experiment 4. Durango markedly ahead in possibilities and forms set.

To obtain data pertaining to the boll and fibre characters ten plants were selected in each of the six plots of each variety on a systematic basis, except where the proper plant had too small a crop, in which case the nearest plant with sufficient bolls to yield reliable data was taken. Table XIII presents the means of the 60 plants of each variety. The exponent numbers indicate the number of other varieties over which any one variety showed statistically significant superiority in any character; thus in the large boll experiment No. 1, Mebane had a percentage of large bolls that was significantly higher than that

TABLE XIII.
SMALL BOLL EXPERIMENT No. 2.

	Bolls counted per plant.	% bolls on M.S.	% 5 locked on M.S.	% 5 locked on V.B.	% 5 locked bolls.	% discused bolls.	% unopened bolls.	Ar. wt. 5 s.	Ar. wt. 4 s.	Seed per lock mean of 20 locks per pl.	Bolls per lb.	Lint Index.	Ginning %.	Strength.	Length.
Mis Del No. 2	19.20 ^(a) *	35.70	7.93	11.30	19.23	33.07 ^(a)	10.58	5.86	4.87	7.45 ^(a)	91.20 ^(a)	6.25	33.21 ^(a)	2.65	3.90
Mis Del No. 1	15.02 ^(a)	45.20 ^(a)	10.43	12.50	23.00	37.92 ^(a)	6.97 ^(a)	6.64 ^(a)	5.04 ^(a)	7.48 ^(a)	76.75	6.67	33.03 ^(a)	2.70	4.44 ^(a)
Durango	12.88	31.75	7.43	12.48	18.35	21.92	17.72 ^(a)	6.18	5.45 ^(a)	7.08	87.20 ^(a)	6.29	30.69	2.60	4.30 ^(a)

LARGE BOLL EXPERIMENT No. 3.

Lone Star 65	19.90 ^(a)	40.27	20.05 ^(a)	26.77 ^(a)	46.88 ^(a)	34.08	4.48	7.16 ^(a)	5.99	7.94 ^(a)	70.48 ^(a)	7.28	33.99 ^(a)	2.64	3.60 ^(a)
Lone Star	15.05	38.10	17.42 ^(a)	33.25 ^(a)	50.57 ^(a)	30.80 ^(a)	8.00	8.07 ^(a)	7.10 ^(a)	7.66 ^(a)	62.25 ^(a)	8.87 ^(a)	36.13 ^(a)	2.54	3.15 ^(a)
Acala	14.55	42.83 ^(a)	26.27 ^(a)	23.48 ^(a)	43.60 ^(a)	40.12 ^(a)	13.50 ^(a)	7.32 ^(a)	6.13	7.38	70.80 ^(a)	7.59 ^(a)	34.13 ^(a)	2.71	4.33 ^(a)
Durango	14.30	27.80	6.52	16.17	22.73	36.33 ^(a)	1.53 ^(a)	6.36	5.60	7.25	81.40 ^(a)	7.04	32.66	3.07 ^(a)	4.50 ^(a)
Wacona	13.80	41.35 ^(a)	20.18 ^(a)	14.35 ^(a)	45.02 ^(a)	38.88 ^(a)	5.88	8.34 ^(a)	7.50 ^(a)	7.76 ^(a)	57.89	8.97 ^(a)	35.70 ^(a)	2.77 ^(a)	4.10 ^(a)
Melane	12.92	44.61 ^(a)	25.78 ^(a)	28.49 ^(a)	54.27 ^(a)	39.29 ^(a)	7.39	8.64 ^(a)	6.57 ^(a)	7.61	59.48	9.42 ^(a)	38.28 ^(a)	2.45	2.86

LARGE BOLL EXPERIMENT No. 4.

Indio Acala	15.42	32.38 ^(a)	18.48 ^(a)	37.50 ^(a)	56.00 ^(a)	39.78 ^(a)	10.18	7.36 ^(a)	6.27 ^(a)	7.33 ^(a)	66.70	8.21 ^(a)	37.28 ^(a)	3.04	4.25 ^(a)
Durango	13.68	16.48	3.45	19.10	22.78	30.45	17.75 ^(a)	6.46	5.64	7.02	81.01 ^(a)	6.93	31.34	3.24	4.33 ^(a)
Miller	13.47	33.00 ^(a)	15.77 ^(a)	39.55 ^(a)	55.35 ^(a)	34.92	8.55	7.83 ^(a)	6.45 ^(a)	7.55 ^(a)	63.76	8.38 ^(a)	35.29 ^(a)	3.46 ^(a)	2.88

Strength Classes—
1 = the weakest,
5 = the strongest.

Length classes—

1 = $\frac{7}{8}$ " and less,
2 = $\frac{7}{8}$ " to $1\frac{1}{8}$ ",
3 = $1\frac{1}{8}$ " to $1\frac{1}{2}$ ",
4 = $1\frac{1}{2}$ " to $1\frac{3}{4}$ ",
5 = $1\frac{3}{4}$ " to $1\frac{7}{8}$ ",
6 = $1\frac{7}{8}$ " and over.

* Small exponent figure = No. of varieties (in the group concerned) which this variety significantly exceeds.

of 4 other varieties, namely, Lone Star 65, Acala, Durango and Wacona. Likewise, Lone Star 65, Acala, Wacona and Lone Star had significantly larger bolls than Durango. There was no significant difference between any of these four varieties, however. Unfortunately it was not possible to complete the analysis of Experiment No. 1 in time for inclusion in the table when forwarding the Report.

Studies were also made of the length of time elapsing from the opening of the flower to the opening of the boll, on individual bolls. No significant differences were obtained between any of the varieties in an experiment, in the January series of flower tagging, all varieties ranging round a mean of 55 days from flowering to opening, except Lightning Express, which was only 51.95 days. A second series tagged in February gave definite indications of the effect of the high temperatures and dry weather ruling throughout March, the individual varietal means ranging from 4 to 13 days shorter period of boll development, with most of the varieties around 7 to 9 days. Strangely, the small to medium boll types did not appear to be hastened to maturity by the adverse conditions more than were the big boll types.

Unfortunately the soil variations showing up under the adverse climatic conditions, caused such marked diversity between plot yields even within the same variety, that it was obvious the yields were not representative of the merits of the varieties. Naturally in none of the experiments were any significant differences in yields obtained. Where the varieties grew somewhat normally, based on their growth at other centres where reasonable yields were obtained, it appeared that the following varieties may have possibilities of replacing Durango for the more fertile alluvial soils of the district :—Mis Del No. 1, Lone Star 65 and Indio Acala. Unfortunately Mis Del 1 produces a long staple of fine diameter, and unless a strain with shorter and harsher fibre can be developed, it is questionable if this variety would be suitable for much of the district. Lone Star 65 is certainly a most promising variety, except in strength of fibre, and as some of the selections obtained in it this season show marked improvement in this respect this handicap may be overcome. The variety is undoubtedly weaker than Durango at present. Indio Acala, while tending to have somewhat long fibre in the experiment, has some excellent shorter types in it, and it appears possible to modify the variety in this respect. The general plant structure of it is somewhat like Durango, and it appears to have the ability to put on a splendid top crop which is a marked asset under Queensland conditions, where the long and variable growing season requires a non-determinate habit of growth.

Not one of the small boll types gave much promise of being a commercial variety for the Callide Valley. Although quick in developing and flowering, the small bolls, low lint percentages (excepting D. & P.L.) and the weakness of the fibres make the varieties tested unsuitable. Of the large boll types, Lone Star, Mebane, Miller and Acala all tended to make rank growth even under such limited rainfall, and all had higher percentages of loss of possibilities through shedding and insect attacks. Wacona, while bad in the latter respect, did not make rank growth, but tended to a semi-cluster type, and the bolls were not only the worst sutured of any variety, but also opened badly and were severe on the backs of the fingers in picking. These objectionable characters were noticed in the variety in all districts where plots of it were tried. Miller had outstandingly the strongest fibre, which was also of good character and suitable length. Unfortunately this variety tends to make rather rank growth on the alluvial soils, but may develop into an excellent cotton for the harder and less fertile soil types. It is unfortunate that more reliable yields were not obtained in the experiments. With such a range of boll and fibre characters, thoroughly indicative yields are required before the true merits of the varieties can be determined.

PURE SEED OPERATIONS.

The operations connected with developing supplies of improved seed of the Durango variety were continued along the usual lines. Exceptionally good yields were obtained in the progeny block, considering the season. The progenies were planted on a fallowed plot adjacent to the site of last season, and although a few tests of selections of previous seasons were affected by some droughty spots, the yield of the block was at the rate of 1.680 lbs. seed cotton per acre, which is well above the average for previous seasons. Some exceptionally heavy bearing and evenly fruited progenies were obtained in some of the older strains, which also picked easily, the bolls being of nice type. Although the yields were entirely satisfactory, the strength of fibre of all the progenies was below that normally obtained, as was the lint percentage, due undoubtedly to the combination of seasonal conditions and the heavy crop borne.

Yield tests of the most promising strains which were carried out in the main cultivations failed to give any clear cut results, owing to unexpected soil variation, probably due to the lack of subsoil moisture. The heaviest yielding progenies, however, were those of which the best results were anticipated.

Increasing the stocks of seed of the strains that are being distributed commercially continued with some degree of success, and several hundred acres will be grown by farmers in the coming season for foundation stocks of replacements of the older commercial seed.

ENTOMOLOGICAL NOTES.

The outstanding features of the season in the Callide Valley from an entomological aspect, were the incidence of mass migrations of cutworm (*Euxoa radians*) early in the season, and corn-ear worm (*Heliothis obsoleta* Fab.) at mid-season, the severe amount of damage caused by the rough bollworm (*Earias huegeli* Rozenk) destroying the tips of the main stalk and vegetative branches, and also the squares and bolls, and the occurrence of the pink bollworm in rather disquieting numbers in several cultivated fields close to scrub areas.

The main difficulties experienced at the Research Station were a most phenomenal migration of cut-worms from an adjoining weedy field, heavy loss of terminals and fruit early in the season owing to the rough bollworm, and a more or less constant, light to medium, attack of corn-ear worm through the greater part of the season.

During July it was noticed that any scattered plants of pigweed (*Portulaca oleracea*) and bullhead (*Tribulus terrestris*) in the fallows were nearly certain to have numerous cut-worm larvæ. Unfortunately an adjacent 60-acre field infested with weeds through the failure of a wheat crop, provided excellent conditions for the increase of this brood, and by November an enormous population had developed. The food supply was soon eaten out and as soon as a migration developed, five furrows were drawn between the Station cotton and the infested field. In making the furrows the soil was first thrown towards the cotton crop and then the return trip of the plough cut away the soil, leaving a clean side surmounted by loose crumbly soil next to the plants. Such a furrow was found to be effective to a remarkable degree without poison, as many of the larvæ, having once fallen into the trench, could not get up the other side and were killed with the heat of the mid-day sun. At one stage, when the supplies of poison were exhausted for three days, the attack was held up by the furrows alone. The bottoms of the first four furrows were baited with the usual 1 to 25 paris green-bran-molasses mixture and renewed when required, altogether 14 baitings being made. The attack was effectively controlled, and demonstrated thoroughly that mass migrations can be prevented from doing serious damage if the proper methods can be used. As an indication of the intensity of the

attack in some portions of the field, the following counts of population representing two nights of migration in the heaviest portions of the peak period, were reported :—

Sandy clay slope.	1st	trench,	556	larvæ	in	6	ft.
	2nd	„	185	„	„	„	„
	3rd	„	111	„	„	„	„
	4th	„	9	„	„	„	„

It was noted that the larvæ would travel upwards of several hundred yards over bare fallow, travelling a little further each night.

Somewhat comparable attacks were experienced in several sections of the Valley, and where reported in time, the Assistant to the Entomologist and the Cotton Instructor were able to demonstrate effective control. Growers are being urged, as a part of their cotton-growing equipment, to carry stocks of materials for the poison bait, as the damage is so quickly done by migrations that there is often no time to purchase supplies after the outbreak.

The rough bollworm has been reported from all districts during the last three seasons as doing an increasing amount of damage each season. Damage from this pest was first noticed this season at the Station in mid-November, when serious losses of terminals occurred in the more sappy fast-growing cotton. Some damage was also caused by the Tip-borer (*Crocidosema plebiana*), but this pest was not seen after December, while the rough bollworm was present throughout the season, although it eased off to some extent during the heat waves in February and March. The bollworms entered large bolls and squares, and attacked terminals of plants in all stages of growth, and undoubtedly caused loss of crop of economic importance. An overwintering host plant (*Melhania abyssinica*) for *Earias* was found by Mr. Strong, Assistant to the Entomologist, on the hilltop on the Station. At late mid-winter moths were emerging from this source, indicating that the exceptionally wet winter season had not affected them.

Corn-ear worms were present at the Station from early season onwards and caused a more or less continuous light loss of squares and small bolls, particularly in the crops on the older cultivations. An appreciable amount of damage was also done at mid- and late mid-season in portions of the crops on the newer cultivations, where the plants were inclined to more sappy growth than usually occurs on these soil types. Beyond a light migration occurring at the start of the trouble with cutworms, no concentrated corn-ear worm attacks were experienced at the Station. In some of the commercial crops,

however, where pigweed grew abundantly adjacent to the cotton, and also within the crop during the month of maximum increase, the incidence of larvæ was so heavy in the following generation that exhaustion of food material occurred, resulting in serious migration to the adjacent cotton plants. In the most serious cases, complete defoliation of the plants as well as destruction of all crop and terminal buds resulted, several hundred acres being affected.

The pink bollworm, while occurring here and there over the Station, was found in sufficient quantities to be disturbing in some of the commercial crops, where no damage of importance had been experienced before. Investigations showed that these fields were mostly within half a mile of abandoned old standover crops which had been grown in scrub burns of the previous season, and where, through inability to grass the land, it had not been possible to burn the old cotton crops. A very heavy population of the pink bollworm was usually present in these standover crops, as many as five larvæ being found in some of the green bolls on the old plants. As such a population indicated that a substantial infection of the crop in the scrub had taken place in the previous season, further examination was made to discover the source. It was found that the standover crops were adjacent to sections of the scrub where hibiscus (*H. divaricatus*) occurred. The capsules of this shrub frequently contained from one to three pink bollworms. Examination at the ginneries as to the efficiency of the heating of the planting seed by the Simon's Heater indicated that a thorough kill was being obtained. It would appear, therefore, that the pink bollworm may be indigenous to the scrub, which is a plausible theory, for the scrub is connected along a chain of hills with the coastal areas where *Platyedra scutigera*, the indigenous pink bollworm of Queensland, has been reported by Dr. Holdaway.

Stainers occurred in varying numbers during the season, with possibly smaller populations of the False Stainer (*Aulacosternum nigrorubrum* Dall.) and the Harlequin Bug (*Tectacoris lineola* F.) than are usually experienced. Although the cotton at the Station did not appear to be excessively stained, the gradings reported from the ginnery for the district indicated a very high percentage of wasty, yellow spotted cotton. This may have been caused by the fact that so much of the crop developed late in the season—the top bolls usually contain more stained cotton than do the middle and lower bolls. The Greater and Lesser Stainers (*Dysdercus* *sidæ*) and (*Oryzarenus luctuosus*) probably contributed markedly to the results obtained.

The following were also noticed in the crop during the season:—Aphis (*Aphis gossypii*), The Looper (*Antarchæa chionosticta*), Jassids

(*Empoasca* sp.), Coon Bug (*Carpophilus* sp.), Terminal Sucking Beetle (*Lixus mastersi*), and a green translucent Capsid Bug which was noted last year and occurred again in large numbers.

GENERAL REMARKS ON THE 1932-33 COTTON CROP IN QUEENSLAND.

A further increase in acreage under cotton occurred this season, 3,655 growers reporting 74,610 acres having crop possibilities at late mid-season, while seed sufficient to plant approximately 80,000 acres was issued. The low prices ruling for agricultural crops, the returns received from dairying, and the yields obtained from cotton as compared with other crops under the disastrous conditions of the previous season, all contributed to a greater interest in cotton-growing. In addition to these factors many growers increased their acreage in the hope of a good season occurring and helping them to recoup their losses in the previous crops. Financial assistance at a low rate of interest, made available from a joint fund operated by the Federal and State Governments for the alleviation of the unemployment problem, also contributed markedly to an increase in the acreage, especially in the Callide Valley. A total of £32,000 was loaned at 3% interest for financing the cultivated crops and falling scrub, the latter being done mostly by unemployed labour, either on a share-farming basis or employment by the farmer. In spite of the disastrous conditions, approximately 60% of this loan will be repaid out of the crop of this season. As the crops of distressed growers are being re-financed for the coming season, it is anticipated that practically all the unpaid loans will be liquidated.

The seasonal conditions were somewhat similar in all districts and the absence of sufficient subsoil moisture affected the crops generally. Undoubtedly, had better subsoil moisture been present, fair to good yields of cotton would have been obtained, even with the heat waves of mid-January and throughout March. As it was, the returns from cotton were better generally than those obtained from other agricultural crops on the same farm.

Confirmation of the advantage of planting on cultivation the first year out of grass land in both forest and scrub soils was obtained in several districts and with different varieties, the yields usually being several hundred pounds of seed cotton per acre higher than those of similar varieties and of the main commercial variety of the district grown on previously cultivated land.

The receipts of seed cotton at the time of writing the Report

(November) amounted to 17,715,229 lbs.—with a small amount still to come in—a low yield for the acreage planted, but good for the climatic conditions of the last two seasons.

All growers realize the cause of such yields and appreciate that with more favourable conditions in March, the yields generally would have increased materially. Some shrinkage of acreage has occurred in the 1933-34 season, in the dairying districts with small farmers, the farmers having to concentrate on replenishing fodder supplies. Seed applications are, however, still being received, and it would appear that in general the acreage of last season will be maintained.

As the winter and spring rainfall has been extraordinarily good in most of the districts, ample supplies of subsoil moisture are available. The planting rains have also been opportune, and the crop appears to be in the best condition of any for many seasons.

SOUTH AFRICA

REPORT OF THE CORPORATION'S WORK AT THE STATIONS AT BARBERTON, TRANSVAAL, AT MAGUT, NATAL, AND IN SWAZILAND, FOR THE PERIOD 1930-33.

INTRODUCTORY NOTE BY MR. S. MILLIGAN.

The annual Experiment Station Reports of the Empire Cotton Growing Corporation in the Union of South Africa and Swaziland during the two previous years, in accordance with the new arrangement, have been abbreviated so as to include only the more important results of the season's work. This year, by rotation, space has been allotted to the South African section for more detailed accounts and for some discussion on the investigations. The drawing up of reports including both an account of the past year's working and some mention of that of previous years has been found a somewhat difficult task by the writers, who have little time to spare. Some of the more important results are obscured by the detail which a triennial report involves, and the writers have accordingly been asked to prepare a brief summary of these to be prefaced to the main body of the report.

The detail necessary to a description of the large amount of new work initiated during the past two years has swollen the report of the Insect Control section to such an extent as to preclude its appearance in this publication in anything but a summarised form. It is hoped, however, that the full report of this section will be issued in the form of a separate publication.

During the last three seasons particularly difficult farming conditions have been encountered. There has been a general lack of rain, cumulative in its effect in reducing reserves of soil and sub-soil moisture and thus rendering the life of all annual crops a precarious hand to mouth existence. Such conditions appear to be particularly liable to produce hailstorms and, as may be well imagined, dust storms are a frequent occurrence. All this makes plot-experiment work most difficult. Continuity has, however, been preserved, largely through a good scatter of the Stations and by the willing co-operation of outside growers. Very considerable progress in many directions has to be reported, as will be seen from a perusal of the Reports. A few of the more important items may be mentioned.

Cotton Plant Breeding.—The original U. 4 selection possessed, in addition to high jassid resistance, valuable properties which enabled it to pull off a good crop even in adverse climatic conditions and even under subjection to intermittent attacks by bollworm. Re-selections from the parent variety with the object of permanently fixing these characters has been in progress for some years and has resulted in the production of a number of strains, the best of which promise an increase of 10 per cent. to 15 per cent. in yield of lint over the U. 4 bulk. These have now been thoroughly tested all over the Low Veld under the dry conditions prevailing during the past few years, but have yet to be grown in years of heavier rainfall before a final decision can be arrived at as to which will be the best all-round strain for the Low Veld.

The more recent selection work has, among other things, aimed at improving the earlier maturing types in the direction of increased strength to fortify the plants against the strain imposed upon them through carrying a heavy, well-advanced crop in periods of drought. From the other end of the scale the elimination of the obvious disadvantages of some of the later, but otherwise desirable types is being carried on by selection.

The great bulk of the cotton grown in the Low Veld consists of unselected U. 4. In a few cases seed of one or two of the older selections (mainly U. 4/4) has been issued to growers at their own request. No recommendation has been made as to growing re-selections, as it is necessary, as has been indicated, to have these tested under better growing conditions than we have lately experienced.

Especially in its resistance to jassid U. 4 Bulk has thoroughly stood the test of adverse conditions. It has rendered cotton-growing economically possible at prices which a few years ago would have been thought quite impossible, and the continuance of the crop in the Low Veld, reduced in area though it is, would not have been possible with any other variety hitherto tested. That the position is essentially more healthy than it was ten years ago, with cotton at more than three times its present price, is indicated by the tendency towards an increased area for the season now commencing.

An advance consignment of crosses, with U. 4 as one of the parents, was received from Dr. Harland, Trinidad, in time for planting in last season. Some of these show considerable promise and their progress will be watched with interest.

Plant Physiology.—The lack of accurate knowledge on a large number of agricultural problems in the Low Veld constitutes a severe handicap, not only to scientific work at the Station, but to general

farming practices in the districts. This is accentuated by the fact that no traditional knowledge is to be found as in the case of older arable tracts. Far too much rests on "opinion" of which there has been no real confirmation. An attempt is being made to investigate some of the more obvious problems at all the Stations through plot experiments. The Plant Physiology section at Barberton is dealing with others requiring whole-time attention and additional facilities in the way of apparatus, etc.

Immediate results cannot be expected, more especially as the seasonal incidence of rainfall is very irregular and temperatures also vary greatly. Reports, therefore, are mainly concerned with work in progress.

Two new lines of work have been recently started—one to gain information on the important subject of the effects of various crops on soil moisture and nitrate residues and on cotton following immediately after them—the other to throw light on the effects of the compactness of soil at planting time in varying seasons. Both questions are of great importance in designing suitable cotton rotations and in actual farm practice in preparing the land.

As a result of last year's records interesting figures were obtained with regard to moisture and nitrate after maize, sunflowers, soya and tepary beans, and cotton, and the work promises to be ultimately of great value.

Rotation Crops.—The question of obtaining suitable rotation and catch crops for cotton farmers has all along been recognised as an important function of the Cotton Stations. The problems are to a large extent local. Investigations have not only been directed towards ascertaining what crops can be grown in the districts concerned, but have included variety trials, spacings, times of planting, fertilizing, etc. Their after-effects on a succeeding crop are now being investigated. Maize has assumed a fresh importance owing to recent researches into the habits of the American bollworm.

District trials of the various crops have shown that even the small number of crops to which the original collections have been reduced vary considerably as to their suitability for the local conditions represented by the Cotton Stations. Thus, while groundnuts continue to do well at Magut and in the Swaziland Lower Middle Veld they appear to be too susceptible to the "rosette" disease for Barberton. Again, soya beans have done well at Barberton, but are considered too risky under the somewhat different conditions found at Magut. There is a general agreement as regards varieties in the plot results from all the Stations. Spacing results vary with local conditions and the

character of the season. There can thus be no general optimum spacing, but it is important to know the advantages and disadvantages at both ends of the scale.

Results obtained during the last few years may be said to be fairly conclusive in most cases, but they refer only to the dry conditions met with. Experience of seasons of higher rainfall is now required. The subject of the inter-relations of cotton and other crops in the rotation are likely to assume increasing importance.

Insect Control Section.—The necessity for a closer study of insect pests of cotton in relation to their host plants led to the establishment of a special Section at the Barberton Station to deal with the subject. The very existence of the crop in the Low Veld was seriously threatened by the depredations of injurious insects, which had multiplied enormously with the expansion of the area under cotton. The jassid menace, it is true, had been overcome, but there still remained the bollworms and the bollrot-inducing stainers.

The Section was established in 1930 but much investigation had to be made before a decision could be arrived at as to the most effective means of obtaining the necessary additional information required. It was finally decided to adopt the methods of recording described in the report. That of investigating the American bollworm is worthy of special mention. This insect is in no way specific to cotton. It is in fact a recognised pest of a whole range of farm, garden and orchard crops. An investigation of its incidence in the cotton crop only thus gives a partial picture of its activities. It may in fact give a very misleading one. The method adopted includes records of egg-laying by the moths not only on cotton, but on adjacent crops throughout the season. An accurate view of the distribution of the eggs of the pest is thus obtained.

The recording has been in operation for one year only, but important information has already been obtained with regard to the maize crop. Maize is a recognised trap crop for the American bollworm, but actual results in South Africa have been disappointing and the practice has now disappeared. Last year's records indicate plainly that the moths showed a definite preference for maize to all the other crops grown, including cotton, for a period of about three weeks dating from the commencement of the tasselling period. The value of such precise information on the subject from the point of view of the protection of cotton by maize growing can scarcely be overestimated.

The observations were conducted at the Barberton Cotton Station and on a number of farms in the surrounding district. Results were most conclusive, both as to the preference for maize at the right stage

and the remarkable protection given by this crop to adjacent cotton. The recording work is being continued and extended to other districts as far north as Mazabuka in Northern Rhodesia so as to cover as wide a range of conditions as possible.

Want of space precludes mention of the other activities of this Section. These are to be found in the report. It will be seen, however, that the cotton stainers are being studied separately under Mr. Pearson and that considerable progress has been made in obtaining a fuller knowledge of their wild and cultivated host plants.

COTTON EXPERIMENT STATION, BARBERTON. REPORT FOR THE SEASON 1932-33 AND GENERAL REVIEW OF RESULTS TO DATE.

SUMMARY.

COTTON.

General.—The season 1932-33 was thoroughly bad for all dry-land farming in the area. The rainfall was much below the average for the third season in succession, and very badly distributed. A five-weeks' drought at a critical time, January—February, seriously affected the cotton crop, particularly where it was early and well developed. In such cases the crop was reduced to about 400-600 lbs. of seed-cotton per acre. Where the crop was later, however, it stood up extremely well and gave yields of about 800 lbs. per acre. The results are very good in the circumstances and when compared with other crops, and indicate more than ever that cotton is definitely the most suitable dry-land crop for the area.

On the Station good early stands were obtained but a dust-storm early in December, followed by hail about ten days later, ruined the stands over some of the experiments. The crop as a whole stood up to the conditions remarkably well and yields of from 800-1,000 lbs. of seed-cotton per acre were obtained from the less damaged areas.

Windbreaks have now been planted throughout the Station in an attempt to reduce the damage caused by any future dust-storms.

Selections.—The selection work was hampered by poor stands, but definite progress was made with most of the material. The dry conditions showed up the tougher strains very well, and many of these gave an excellent crop and as good yields per plant as have ever been

obtained. The seed for carrying on, both from single plants and bulks, is in larger quantity and of much better quality than for several years past.

Seed of a number of crosses between U.4 and other cottons was received from Dr. Harland and planted in small plots. Some of these showed considerable promise, being tough and cropping well, and selections have been made for carrying forward. Jassid was not bad enough to test them severely, but most of them were obviously resistant. A further large batch of crosses has been received, largely from U.4 and Cambodia, and these will occupy about five acres in the coming season.

Variety Trials.—The main variety trial, comprising the best twelve old U.4 strains compared with U.4 Bulk, gave reliable figures from nine repetitions out of the original twelve. Owing to the nature of the season the stronger strains showed up best. Figures are now available for ten trials of these strains, totalling 82 repetitions, carried out in various places during the past three years. Eight strains have given an average increase over U.4 Bulk of 10–15 per cent. in lint yield and have been consistently good.

Small bulks of a number of newer selections, including re-selections of the above strains, some of them certainly better than their parents, are now available for variety trials and observation plots. Small variety trials of these sub-strains were planted during the past season, but had to be abandoned as they suffered very badly from the dust-storm. It is confidently believed, however, that there is very definitely better material amongst these newer strains than any of the older strains that have established their superiority over Bulk.

Fertilizers.—This season Phosphate, for the second time, has given a definite increase in yield of seed-cotton, this result being obtained in two separate experiments. It appeared to put a little more body into the young plants during their early vicissitudes. Potash has given a smaller, but just significant, increase in yield.

PLANT PHYSIOLOGY.

It has been observed repeatedly, both at Barberton and Bremersdorp, that the early growth of cotton is much poorer on land that was fallowed in the previous season than on land that was under crop. The cotton crop remains backward for some considerable period, though it may catch up in a long season. A series of experiments has been carried out to investigate this effect. As yet no satisfactory explanation of the depressing effect of fallow has been found, but it has been shown not to be due to the differences in soil nitrates or to differences in roughness of ploughing found after fallow and crop

respectively. A possible explanation has been put forward, which it is hoped to test in the coming season.

Investigations in 1931-32 of the effects on the cotton plant of different times of ploughing showed a beneficial effect of autumn ploughing as compared with winter or spring ploughing, but no difference between the last two. Autumn ploughing was carried out at the end of April following late rains, winter ploughing at the beginning of September when the soil was very dry, and spring ploughing in October or November after the spring rains.

A rotation experiment laid down in 1932-33 has already yielded some valuable information. The six treatments are :—cotton, maize, sunflowers, soya beans, tepary beans and fallow alternating with cotton in a two-year rotation. At the end of the season considerable differences were found in respect of the moisture and nitrates left in the soil by the five different crops and fallow respectively. The sunflowers had dried the soil very considerably at all depths down to 5 feet, and the soya beans had produced a similar but rather less drastic effect. The tepary beans had removed less moisture than any other crop and had produced very little effect below 2 feet (although they had removed some moisture even at 5 feet depth). The maize and cotton were intermediate between tepary beans and soya beans in their effects on soil moisture, but it should be mentioned that the cotton was late planted and very small. The importance of these soil moisture differences from the point of view of the succeeding crop need scarcely be stressed. With regard to soil nitrates, it was found that sunflowers, soya beans and maize had all three lowered the nitrate content considerably as compared with tepary beans and cotton. Also that the two last had lowered it to a much smaller concentration than that found on fallow. It is intended to carry on this experiment for a number of years.

A cultivation experiment was carried out in 1932-33 in which the treatments were such as to produce different degrees of soil compactness. The effects on the cotton crop and on soil nitrate, penetration of soil moisture, etc., were investigated. The effects of the treatments in an experiment of this nature are bound to depend to a great extent on the type of season. Interesting results have been obtained for 1932-33, but it would be premature to discuss them until the experiment has been repeated in several seasons. It may be mentioned, however, that the treatment giving the least compact soil gave a later crop than the other two treatments.

The effect of meteorological conditions upon the growth and development of the cotton plant continues to be investigated. As

has been noted in previous reports, high air and soil temperatures have been found to be of very great importance for the growth of cotton at Barberton.

ROTATION CROPS.

Maize.—Preliminary trials of a large number of maize varieties have resulted in the retention of three types suited to various purposes. White Flint has given the best all-round results, showing a good degree of resistance to drought. Arkell's Hickory has proved the best long period, dent type, whilst Peruvian Yellow, a small round red-yellow maize, combines a short maturation period with high powers of resistance to Streak virus disease and should be useful for very late planting.

Soya Bean.—Study of soya bean varieties has shown the Yellow 1 type to combine good yield qualities with high resistance to shattering of grain when ripe.

Spacing experiments show that a distance of 2 feet 8 inches to 3 feet between rows and 4 inches to 5 inches between plants is about the optimum, using the Yellow 1 strain.

Minor investigations demonstrate the importance of seed size and depth of planting in obtaining a satisfactory stand with soya beans.

Tepary Bean.—Tepary bean has grown well and proved one of the most useful legumes. It takes little moisture out of the soil and can be got off early, thus leaving the land in good condition for autumn ploughing. A spacing experiment gave inconclusive results.

Groundnuts.—In variety trials the Barberton strain (renamed from a Gudiatham Bunch) has held its own as the best yielder.

Time-of-planting experiments show that late-planted groundnuts are affected by "Rosette" virus disease to a very much greater extent than earlier planted crops.

Sunflower.—A striped strain, St. 3, has proved itself superior to all other introduced lots, giving a good yield in a reasonably short time. B 4 is the best of the black-seeded, longer period types.

Spacing trials indicate that with 3 feet between rows, the best distance between plants is 18 inches to 24 inches for St. 3, and 30 inches for B 4.

Miscellaneous Legumes.—A strain of Lima bean still promises to be of use, while sugar beans, kidney beans and other allied *Phaseolus vulgaris* species are definitely useless as rain-grown crops.

INSECT PEST CONTROL.

Since the report of this Section is already in an abridged form no summary is given here.

COTTON BREEDING AND GENERAL

BY

F. R. PARNELL AND D. MACDONALD.

Season.—In common with most other parts of South Africa this area has experienced an extremely difficult season for ordinary dry-land farming. It was the third consecutive season with a rainfall well below the average and there is little doubt that sub-soil moisture was abnormally low from the beginning. Rainfall distribution was bad and there was a serious drought, lasting for five weeks, during the latter part of January and the whole of February. This will be seen from the rainfall table and chart at the end of this section of the report. A shower of 0.60 inches on February 10th only penetrated about two inches into the dry soil and was of no use to the roots.

All crops that were well advanced at this time were very badly hit, maize being killed out altogether, and cotton, though seriously damaged, standing it better than anything else. Some of the worst affected cotton crops still gave 400–600 lbs. per acre of seed cotton. Less advanced cotton, especially where the stands were thin, came through very well indeed and in many cases gave over 800 lbs. per acre. In the circumstances these results are most satisfactory and they made a considerable impression on the farmers in the area. It is quite obvious that cotton is the most suitable crop they have for dry land and a small rise in prices would see an immediate and substantial increase in the acreage planted.

Rainfall records for Barberton are available from 1889 to date, with the exception of five years during and after the Boer War. It is obvious from these records that for the past seven or eight years the rainfall has been well below the average. The figures are erratic, both for yearly amount and distribution, and it is not possible to speak of a normal season. It is reasonable, however, to expect that in the near future there will be some improvement and that very dry conditions will be less common than they have been since this Station was started. Further reference to this question will be made later in discussing variety trials.

On the Station the drought was not so serious from the point of view of the work on cotton. The soil is a very deep loam and, after once being well wetted through, holds a crop well during drought. Stands were generally thin but the crop went through remarkably well, and yields of from 800–1,000 lbs. per acre of seed-cotton were obtained from all but the worst stands.

The real difficulty on the Station was caused by a dust-storm on December 4th, followed by heavy winds and some hail on 15th and 16th. The young crop was severely damaged; stands were ruined

in some places and the surviving plants received a serious setback. This damage affected the work most seriously in experiments where plot-yields were required, as in some cases the final stand was much too bad for such yields to be taken.

Dust-storms have damaged the young crop in the past two seasons and the possibility of the continuance of this experience is a serious menace to the work. They are said to be unusual, and it is true that nothing of the same nature occurred in the previous seven years, but steps have been taken to plant windbreaks, at intervals throughout the Station, in an attempt to overcome this danger. *Cassia siamea*, a strong bushy tree, is being used for this purpose and is doing well. Transplanted seedlings have been used, instead of the more usual method of planting at stake, as the conditions have been too dry for the latter method.

It may be of interest to note that the seedlings are raised in paper bags, ordinary square-ended, 4 ounce, brown bags being used. These are filled with soil, three seeds sown in each, and arranged in the form of long beds with the bags touching. The interstices are filled with sand and the whole treated as an ordinary seed-bed. The bags mostly rot away but the balls of earth remain firm and are easily separable on account of the sand between them.

SELECTIONS.

The selection area was a good deal damaged by the dust-storm and stands were bad in some places. This made comparisons difficult and hampered the work generally, but, in spite of this, useful progress has been made. The difficult conditions tested the strains severely and it was possible to discard some whole families that were not tough enough and that had shown the same failing previously. This makes it possible to concentrate on better groups that have done well regularly, and marks a definite step forward.

Generally speaking, the early types were most badly hit by the conditions, partly through lack of strength and toughness, partly through the drought having caught them at a time when they were trying to make their crop. A few types are definitely too small, early, and lacking in real robustness to be safe for general cultivation, where they may meet poor conditions fairly often. Unfortunately, 955, a very beautiful early strain and wonderful cropper for its size, looks like falling into this category eventually. Some of its sister strains, however, derived with it from 4/4/2, are definitely stronger and show very considerable promise. This may be seen from the results given by them—Nos. 938 and 951 of Table I.

The season definitely favoured the stronger types and many of these stood up to the conditions very well indeed. They gave excellent yields, as good as have been obtained previously in good seasons, and the lint was of quite good quality. The poor stands, of course, helped the plants considerably during the drought, but, nevertheless, their behaviour was most satisfactory.

Records are given in Table I of special bulks of a number of strains covering the range of selections. The figures give a good idea of the general nature of the material and at the same time show the excellent yields obtained in spite of very poor conditions. The plants chosen for these bulks are good plants, typical of the strain concerned, taken after any single-plant selections have been made. In some cases, where the stand was very bad, such bulks were taken to carry on the strain in preference to selecting single plants.

TABLE I.
RECORDS OF SMALL SPECIAL BULKS OF U.4 SELECTIONS.

	<i>Family.</i>	<i>Lot No.</i>	<i>No. of Plants.</i>	<i>Yield per plant seed cotton gms.</i>	<i>Boll Wt. gms.</i>	<i>Ginning %</i>	<i>Wt. 100 Seeds gms.</i>	<i>Lint Length mm.</i>
Early	938	23	8	206	4.8	36.8	9.5	32.4
	938	08	8	174	5.0	36.0	10.3	32.5
	938	010	8	162	4.8	35.3	9.6	32.0
	951	28	7	199	4.9	37.1	10.4	31.6
	951	212	10	162	5.3	35.2	10.2	33.0
	4/4	052	15	174	5.2	35.2	9.8	32.0
	4/4	231	22	166	5.1	35.8	9.9	32.4
	4/4	233	12	163	5.3	36.0	9.0	32.3
	9158	2115	12	150	4.7	34.5	9.9	31.4
	9158	2116	16	166	4.7	35.8	9.8	30.5
	9158	2120	20	141	5.0	36.3	9.4	31.7
Medium	9130	299	12	213	4.4	33.6	9.1	32.7
	9130	2101	8	217	4.0	33.5	8.8	31.1
	9130	2111	8	192	4.4	34.7	8.4	32.4
	9243	2122	12	163	4.9	35.6	9.4	31.0
	9243	0289	12	192	4.8	36.6	8.4	31.0
	9355	2179	16	174	4.5	38.0	8.5	31.2
	9355	0239	20	178	4.4	38.5	8.0	29.7
	9355	0245	16	167	4.3	37.9	8.7	30.2
	9347	0221	32	245	4.6	38.8	8.5	30.0
	9347	0222	30	174	4.1	39.5	7.8	30.0
Late	920	0269	14	206	4.6	37.8	9.1	30.1
	920	0270	14	195	4.7	38.0	8.5	29.7
	920	294	14	193	4.8	38.3	9.3	30.1
	921	269	16	176	4.6	37.5	8.7	30.6
	921	270	14	203	4.8	37.4	9.1	30.4
	921	272	12	199	4.7	37.7	8.5	29.7
	9264	2130	18	230	4.5	36.9	8.1	32.2
	9264	2133	10	227	4.7	36.5	8.7	30.7
	9264	0343	12	228	4.5	35.3	9.8	30.6
	9292	0116	12	204	4.6	35.4	9.6	30.1
	9292	0118	14	212	4.5	36.2	9.2	29.7
	9292	2149	14	178	4.6	35.2	9.3	30.8

A number of old bulks, which have in the past given rise to good selections, will be planted again in the coming season alongside their

latest progeny. They will be compared carefully with their progeny and further new selections will be made from them if it appears to be worth while.

The best strains still cover rather a wide range in habit and general characters of the plant. All selections, except in a few special cases, are made on the basis of increased lint-yield without loss of desirable lint characters, no preconceived particular type of habit being aimed at. It is found, however, that the more extreme types, both as regards habit and agricultural characters, are gradually dropping out in the process of selection on the above basis and that very marked characteristics are being moderated.

In the absence of serious attacks by stainer there was very little internal boll-rot this season and the seed obtained from the selections is of very good quality in addition to being in greater quantity than for the previous two seasons. This will make it possible to plant good plots of single-plant lots and still keep a useful reserve.

Jassid Resistance.—During the last three seasons jassid has not been very severe. It has been enough to prevent plots of the old local varieties, Bancroft, Griffin, etc., from giving a crop, but not enough to show up differences in resistance in the selections. It is hoped that a bad jassid year will be experienced again very soon in order that the strains may be thoroughly tested. At the present time it is difficult to say whether the existing strains are as uniformly resistant as they can be made by selection.

With a view to obtaining increased resistance to jassid, among other objects, crosses have been made by Dr. Harland between U.4 and a number of other cottons of widely different types. Seed of a few advance lots of these crosses was received from him and planted in small plots in the past season. Some of these lots showed considerable promise, being tough and cropping well, though they were generally on the late side. They were not severely tested by jassid, but most of them showed definite resistance. Selections have been made for carrying forward and these will be planted alongside a further large batch of crosses, mostly from U.4 and Cambodia, since received.

This material offers great possibilities, as it should contain plants combining the desirable characters of several parental types. It is, of course, extremely mixed and it will take a number of seasons of selection work to sort it out and produce strains that are uniform enough to be judged as regards their economic value. Thanks are due for these crosses to Dr. Harland, also to Mr. Evelyn who grew the later generations in St. Vincent and made records on a large number of single plants.

VARIETY TRIALS.

In 1930 small amounts of bulk seed were obtained from the second generation of the main selections from U.4. These selections covered the range of variation in U.4 and included all the types that appeared to be of economic value. During the past three seasons the best of these strains have been tested against U.4 Bulk in variety trials in a number of places. They have been subjected to very varying conditions, both of soil and climate, but generally definitely unfavourable for a really good crop.

Some of the trials planted have been too badly damaged in various ways to give reliable figures. The results for the chief strains of those that were successful, 10 trials with a total of 82 repetitions, are given in a consolidated form in Table II (p. 44). The figures are all based on yields of *lint* and are given as percentages of U.4 Bulk for convenience of comparison. The actual yields of Bulk are given, in pounds per acre of lint, at the foot of the table. In trials 1 and 8 the figures were obtained by boll-stripping, owing to the prevalence of internal boll-rot, and the calculated yield per acre is not given as it would be misleading.

It is felt that, in judging these results, *safeness* is a most important factor. Any strain in general cultivation will meet good, bad and indifferent conditions and it is very necessary that it should be able to do reasonably well in all. It should not be liable to a bad failure, as compared with its fellows and with U.4 Bulk, in any set of conditions, good or bad.

The results on the whole are satisfactory and show a number of strains to be substantially better than Bulk. The figures are by no means regular, since some strains have been favoured by the conditions of one trial, others by those of another. Thus the late-planted trial at Barberton, No. 5, definitely favoured the earlier strains: the same applies to No. 8, at Ingwavuma, where it was principally the early-set crop that counted. These two trials have put up 998 into first place on the mean results, 20.7 per cent. better than Bulk. It is a good strain, but this mean figure is accepted with some reserve, as compared with other strains, since the above two trials represent rather exceptional conditions.

Of the thirteen strains given in the Table five have been discarded. Both 4/2 and its daughter strain 913 are late and too much inclined to run to wood. They have been discarded in favour of 920, a much better selection from 4/2, though the latter will be grown again for making further selections. No. 9275, from the old H.77, has done badly and has obviously been a poor drought-resister from its appearance in the field. No. 9331 has not done well and is a bad opener.

No. 9312, from Z.9, started well, but has failed rather badly in some of the trials, as well as on multiplication plots and the selection area. Its lint is not of good spinning quality and it is definitely not worth keeping.

It may be of interest to give some notes on the more successful selections :—

955, from 4/4 via 4/4/2, is the earliest and smallest strain. It makes a beautiful plant, carrying a very heavy crop for its size, but is not strong enough for really poor conditions. It is very uniform and offers little hope of improvement by selection.

998, from 4/4 via 4/4/10, is a stronger, early, heavy fruiting type of considerable promise. This strain also is uniform and not likely to respond to selection. The ginning percentage is very high, about 40 per cent.

4/4, one of the first original selections from U.4, is consistently good. It is early, heavy-fruited, with fair strength though not a strong grower. Later selections from this strain offer every hope of a decided improvement. All three of the above strains, being early and on the fine side, are rather less resistant to jassid than most of the later ones.

9243, from C.28, is a medium type generally and has done well regularly. Selections from it do not offer great hopes of improvement.

9355, from Z.14, a type of medium size and stiff wood, has done well generally. It has now been very much improved and the later selections are very good in every way. They are definitely earlier and less bushy and their opening is far better.

9292, from A.6, is a rather strong leafy type with promising selections.

921, from a very aberrant plant in 4/4, is a most distinct type. It is fine-wooded but bushy and spreading, and fruits heavily over a long period. It is always one of the best looking lots and has given very good results in the trials. It is somewhat irregular as it stands, but its re-selections are more uniform, though varying between themselves, and are very promising.

920, from 4/2, is a very sound strain that is strong and tough, without being coarse, but slightly on the late side. It always looks well and has been consistently good in the trials. It is moderately uniform, but its re-selections should result in a decided improvement. The lint of this strain is reported, from spinning tests, to be the best of all those submitted.

Small bulks are now available of a number of newer selections, including sub-strains of most of the above. About forty of these were put into small variety trials in the past season, alongside any of their parents that were standard strains. This block of trials was the most severely damaged area on the Station and no figures could be obtained. Similar trials will be planted in the coming season at Barberton, Bremersdorp and Magut, and it is hoped that reliable results will be obtained. From observations in the field there is little doubt that definite improvements on some of the older strains have been obtained, but the latter cannot be discarded till this has been proved in actual trials.

TABLE II

VARIETY TRIALS OF U.4. SELECTIONS FOR THREE SEASONS. LINT YIELDS SHOWN AS PERCENTAGES OF U.4 BULK.

				1930-31.			1931-32.					1932-33.		Mean
Strain No.				1 <i>Barberton.</i>	2 <i>Bremers- dorp.</i>	3 <i>Ingwavuma.</i>	4 <i>Barberton Early.</i>	5 <i>Barberton Late.</i>	6 <i>Barberton Arkell.</i>	7 <i>Bremers- dorp.</i>	8 <i>Ingwavuma.</i>	9 <i>Barberton.</i>	10 <i>Ingwavuma.</i>	
				12 <i>Repetitions.</i>	8 <i>Repetitions.</i>	8 <i>Repetitions.</i>	6 <i>Repetitions.</i>	6 <i>Repetitions.</i>	6 <i>Repetitions.</i>	8 <i>Repetitions.</i>	8 <i>Repetitions.</i>	9 <i>Repetitions.</i>	11 <i>Repetitions.</i>	Total 82. <i>Repetitions.</i>
955	...	...	...	99	105	139	—	—	106	104	144	91	104	111.5
998	...	...	...	121	110	109	—	153	—	98	160	102	113	120.7
4/4	...	...	...	117	107	104	136	120	103	102	138	106	103	113.6
9312	...	...	...	130	114	134	—	150	96	93	121	103	95	115.1
9243	...	...	...	103	120	127	125	101	—	104	117	108	100	111.7
9355	...	...	...	109	107	112	132	135	94	113	114	97	108	112.1
9275	...	...	...	98	130	91	95	113	90	100	89	—	—	100.7
9331	...	...	...	120	98	96	119	108	93	95	104	—	—	104.1
9292	...	...	...	105	100	93	117	—	104	100	118	102	98	104.1
921	...	...	...	138	114	96	137	112	104	105	127	110	106	114.9
920	...	...	...	112	115	111	116	115	98	109	122	111	102	111.1
4/2	...	...	...	111	99	103	115	99	90	94	109	—	—	102.5
913	...	...	...	111	105	88	129	—	—	95	108	97	—	104.7
U.4 Bulk per acre	Lint	Yield	lbs.	Boll Stripping.	338	293	260	157	457	353	Boll Stripping.	263	265	298

N.B. The strains are arranged in order of earliness, beginning with the earliest.

It is not easy to form an opinion as to the type of season that is likely to be experienced most commonly in future. As already mentioned, however, there is reason to hope that very dry conditions will be less usual. Should this be the case it is likely that the smaller and finer strains, generally speaking the earlier ones, will show to better advantage than they have done in the past. It is possible, also, that stronger and later types may show too much tendency to go to wood. Such possibilities are being borne in mind throughout the selection work, a fact that makes it necessary to carry on material that might otherwise be discarded. It would be a great deal easier, and results would be obtained more quickly, if it were possible to work for a more uniform and definite set of conditions.

FERTILIZER EXPERIMENTS.

Permanent Cotton Fertilizer Experiment.—The experiment started in the previous season was continued. It is a randomized block experiment giving six repetitions, the plots being 10 rows by 90 feet, but only the six middle rows being taken for yields. The fertilizers, as shown in Table III, were broadcast and ploughed in a few weeks before planting.

TABLE III.
PERMANENT FERTILIZER EXPERIMENT ON COTTON.

<i>Fertilizer.</i>	<i>Dressing, lbs. per acre.</i>	<i>Yield of Lint, lbs. per acre.</i>
Superphosphate	250	247
Superphosphate	500	252
Sulphate of Potash	200	236
Nitrate of Soda	200	209
Nil	—	205

Difference required for $P=0.05$, 27.1 lbs. per acre.

The results, given in Table III, show a definite and very significant increase due to phosphate, the normal and double dressings giving about the same. In each of the past three seasons phosphate has shown a beneficial effect, though this was only seen on the dry weight of the plant in 1931-32 as the crop was damaged by stainer. It can be stated definitely that phosphate is required for the best development of cotton on this soil, but the question of how much and how often can only be answered when more evidence is available.

Potash had shown indications of being useful previously, though the increase it gave was not significant. This season's figures bear out those indications as it has given an increase that is just significant.

There is no doubt that nitrogen is not a limiting factor since it has never shown any effect. This is not surprising, since the land had been covered with Mimosa bush for many years and analyses show that the nitrogen content of the soil is comparatively high.

Plant samples were taken from the above plots by Mr. Heath, whose analyses show the following results.

Samples taken on 5.1.33, 58 days from the planting, showed no significant effect for total dry weight of plant, but for dry weight of squares treatment effect was highly significant ($P < .01$). The figures given in Table IV show a definitely greater production of squares for phosphate treatments. This result, indicating greater earliness, is a common effect of phosphatic manuring in general.

Further samples were taken on 19-20.1.33, 72 days from planting, when a few plants had started to flower. Dry weight of leaves was not obtained and fresh weight had to be used instead. There was no indication from the earlier samples of any difference in moisture content of plants on the different treatments, so the results for fresh weight may be taken to apply for dry weight also. The effect of treatment was very significant ($P < .01$) both for total fresh weight and for dry weight of squares, but not for number of nodes on the main stem. The significant differences are shown in Table IV.

TABLE IV.

Treatment.	5.1.33.		19-20.1.33.			
	Dry wt. squares per plant. (mgm.)	Significant differences.	Total fresh wt. per plant (gms.)	Significant differences.	Dry wt. squares per plant. (gms.)	Significant differences.
P1	9.93	P = .05	30.36	P = .05	0.192	P = .05
P2	9.38	3.98	26.52	5.40	0.159	.051
K	5.43	—	23.97	—	0.143	—
N	2.62	P = .01	20.40	P = .01	0.102	P = .01
Nil	5.40	5.43	20.44	7.37	0.093	.070

In no case is there any significant difference between P. 1 and P. 2 but both are significantly higher than Nil or N. K. is not significantly higher than Nil or N., except for dry weight of squares on the second sampling, when the difference approximately reaches the five per cent. level of significance. This difference is borne out by the final yields given in Table III above.

Maize-Cotton Rotation and Phosphate.—When cotton is grown in rotation with another crop on soil requiring phosphate it is a matter of importance to know which crop should receive the phosphate in order that the best return may be obtained from its application. Maize is commonly grown in this area, and it is a crop that responds readily to phosphate. An experiment was laid down, therefore, with maize and cotton in rotation, in order to throw some light on this point. A field has been divided in half for the alternation of cotton and maize

on the two halves. Plots are arranged to give each year and for each crop a comparison between :—

1. Phosphate applied direct to the crop concerned.
2. Phosphate applied to the previous crop.
3. Nil.

The application is at the rate of 250 lbs. per acre of superphosphate.

This experiment has been running for one season only. The maize half of it gave no crop, as the drought prevented the setting of cobs. From the beginning, however, the phosphated plots were obviously stronger than the nil. The effect was so striking that samples were taken at 25 days from planting, to measure the dry weight at that stage. From each of the four plots per treatment 120 plants (480 per treatment) were taken by randomized sampling. The mean dry weights for the two treatments were as follows :—

Effect of Phosphate on Dry Weight of Maize Seedlings.

Superphosphate @ 250 lbs. per acre—1.25 gms. per plant.

Nil .68 gms. per plant.

Probability less than .01.

The cotton plots showed a very large increase due to phosphate and fully confirmed the results from the permanent fertilizer experiment.

The figures were as follows :—

Effect of Phosphate on Cotton.

Superphosphate @ 250 lbs. per acre—321 lbs. *Lint* per acre.

Nil 240 lbs. *Lint* per acre.

Probability less than .01.

BARBERTON.
DAILY RAINFALL, SEASON 1932-33.

	<i>July.</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>	<i>Nov.</i>	<i>Dec.</i>	<i>Jan.</i>	<i>Feb.</i>	<i>Mar.</i>	<i>Apr.</i>	<i>May</i>	<i>June</i>
1 ...	—	—	—	0.46	—	0.09	—	—	0.38	—	—	—
2 ...	—	—	—	0.48	—	0.09	—	0.05	0.87	0.08	—	—
3 ...	—	—	—	0.03	0.01	0.03	0.04	—	0.42	—	—	—
4 ...	—	—	—	—	—	—	—	—	0.86	0.13	—	—
5 ...	—	—	—	—	1.10	—	—	—	0.15	—	—	—
6 ...	—	—	—	—	—	—	—	—	0.26	—	—	—
7 ...	—	—	—	—	0.27	—	—	—	1.00	—	—	—
8 ...	—	—	0.01	—	0.03	0.01	0.02	—	0.44	—	—	—
9 ...	—	—	—	—	—	—	—	—	—	—	—	—
10 ...	—	—	—	—	0.09	—	0.14	0.60	—	—	—	—
11 ...	—	—	—	—	—	—	—	—	—	—	—	—
12 ...	—	—	—	—	0.05	0.14	—	—	—	—	—	—
13 ...	—	—	—	—	—	0.10	0.29	—	—	—	—	—
14 ...	—	—	—	—	0.01	—	—	—	—	—	—	—
15 ...	—	—	—	—	—	1.84	—	—	—	—	—	—
16 ...	—	—	—	—	0.03	0.74	—	—	—	—	—	—
17 ...	—	—	—	—	—	0.32	—	—	—	—	—	—
18 ...	—	—	—	—	0.23	—	0.17	0.03	—	—	—	—
19 ...	—	—	—	—	—	0.26	0.10	0.04	—	—	—	—
20 ...	—	—	0.09	—	—	—	1.19	—	—	—	—	0.25
21 ...	—	—	—	—	0.08	—	0.49	—	—	—	—	0.45
22 ...	—	—	—	—	0.18	—	—	—	—	—	0.69	—
23 ...	—	—	—	—	0.01	—	—	0.05	—	—	—	—
24 ...	—	0.02	0.24	—	—	—	—	0.09	—	0.33	—	—
25 ...	—	—	—	—	0.86	—	—	0.04	—	—	—	—
26 ...	—	—	—	—	—	0.97	—	0.26	0.07	—	—	—
27 ...	—	—	—	1.08	0.01	0.01	—	0.05	—	—	—	—
28 ...	—	—	—	0.18	—	—	0.10	0.32	—	—	—	—
29 ...	—	—	—	—	—	—	—	—	—	—	—	—
30 ...	—	—	—	—	—	—	—	—	—	—	—	—
31 ...	—	—	—	—	—	0.32	—	—	—	—	—	—
Total ...	—	0.02	0.34	2.23	2.96	4.92	2.54	1.53	4.45	0.54	0.69	0.70

Total rainfall for year, 20.92 inches.

PLANT PHYSIOLOGICAL WORK

BY

O. V. S. HEATH.

INTRODUCTORY.

The plant physiological work carried out at Barberton up to date falls for the most part under two main headings. Firstly, investigation of the effects of previous treatment upon the soil and hence upon the cotton plant: under this heading may be included experiments on effects of previous crops or fallow, different times of ploughing, different kinds of cultivation, and fertilizers. Secondly, investigation of the effects of meteorological conditions upon the growth and development of the cotton plant.

With the close of the season 1932-33, the experiments investigating the effects upon cotton of previous fallow or crop with different times of ploughing are being discontinued. The results of these experiments, and of a separate time-of-ploughing experiment in 1931-32, are reported in detail below and discussed in the section headed "Discussion." It is suggested that the general reader should turn to this section in the first instance. The "Experimental" sections necessarily include a good deal of statistical detail. It was felt that this should be included, as these experiments are here reported in full for the first time.

The investigation of time-of-ploughing effect has not helped to explain the depressing effect on cotton of previous fallow. Further time-of-ploughing experiments will not be carried out, but the effects of previous crop or fallow will continue to be investigated in connection with the new Rotation Experiment mentioned below.

The writer fell ill in February 1932, and as a result of this and subsequent leave, was away until the beginning of the next season. The main work of the season (1931-32) had been devoted to the experiment on "cotton after fallow and crop with two times of ploughing" and to the separate time of ploughing experiment, plant sampling being carried out as well as the usual records. Some of the records, sampling etc., were carried on for the writer by Mr. J. D. Jameson, of the Uganda Agricultural Service, and by Mr. H. Hutchinson, to both of whom thanks are due. A large part of the work had to be abandoned, however. Thanks are also due to Mr. Jameson for working up a part of the season's data.

The experiment on "cotton after fallow and crop with two times of ploughing" for 1932-33 was ruined by a hail storm on December

15th, 1932. (Luckily some samples taken before the hail gave useful information, which is discussed in detail below.) The main work of the season was therefore devoted to a cultivation experiment which was comparatively slightly damaged by the hail. This experiment was designed to show the effects of different degrees of soil compactness, and some interesting results have been obtained. It is being repeated in the coming season, and as the results of such an experiment for a single season are of little value, discussion of them will be postponed until it has been carried out over several years.

A rotation experiment was laid down on the loam in the season 1932-33, having cotton following fallow and five different crops in a two-year rotation. The effects of the various rotation crops (and fallow) on the soil and on the subsequent cotton crop will be investigated over a number of years. A start was made at the end of the season 1932-33, when the moisture and nitrate contents left in the soil by the various rotation crops were determined. Plant samples were also taken to find the weight of dry matter produced by each plot of each crop. A similar rotation experiment was laid down on the granite soil.

In 1930-31 a fertilizer experiment was carried out having phosphate, potash and nitrate, applied singly and in combination, and also Nil. The results are fully described in the Report for that year. No significant interactions between fertilizers were found, and in 1931-32 another fertilizer experiment to be retained for several seasons was laid down. This had superphosphate applied at two different rates as well as potash and nitrogen applied singly, and Nil, but no combinations of fertilizers. Records were kept and samples taken by Messrs. Jameson and Hutchinson in 1931-32, while in 1932-33 the writer took plant samples from this experiment on two occasions. The results are given in Mr. Parnell's Report above.

For a number of seasons, measurements of height of main stem have been made every two days for correlation with meteorological data, flowering and bolting records being kept for the same purpose. Beginning with the season 1930-31 these 2-daily measurements of height have been made on plants stripped of squares and monopodia as well as on normal plants. In the season 1932-33 the 2-daily measurements of normal plants were brought to an end by the destruction of many of the plants by hail, but 2-daily measurements of "stripped" plants were begun after the hail and carried on until July. Owing to the writer's long absence in 1932, there has not yet been time to work up fully the data for the 2-daily measurements in seasons 1931-32 and 1932-33. The discussion of the three years' results (1930-33) will be

postponed until they can be reviewed as a whole. It may be mentioned that, as in former seasons, they indicate the great importance of high air and soil temperatures for the growth of cotton at Barberton.

During the past two seasons a good deal of experience has been gained in sampling cotton plants through the season, and finding their fresh and dry weights, etc. An attempt is being made to evolve a technique which shall be both statistically satisfactory and as rapid and convenient as possible.

The writer has to thank Mr. H. Hutchinson for much assistance during the season 1932-33. He has also to thank his assistant, Mr. R. G. Griffith, without whom much of the work of the last three seasons would have been impossible.

Effects of Previous Soil Treatment.

I. Cotton after Fallow and Crop. Winter and Spring Ploughing.

Experimental.

1928-29.—In the Report for 1928-29 it was noted that there was a depressing effect on the early growth of cotton following fallow, as compared with cotton following cotton, maize or beans.

1929-30.—An experiment was carried out on cotton following fallow and maize, with winter and spring ploughing. The detailed results are given in the 1929-30 Report. The combination of maize and winter ploughing gave cotton so very much earlier than any of the other three treatments, that an interaction between the effects of previous crop and time of ploughing was suggested. Since the winter ploughing after maize was very much rougher than after fallow, or than either of the spring ploughings, it was suggested that roughness of ploughing might be the main factor. Differences between treatments were also found for soil temperature, the maxima being higher on the winter-ploughed maize treatment than on the winter-ploughed fallow treatment. The soil was also found to dry more rapidly after rain on the former than on the latter.

The above experiment was not properly replicated and the results obtained might have been due to purely positional effects.

1930-31.—No experiment on this subject having been laid down in the previous season, observations were carried out on a field that had been half fallowed and half under cotton the previous year. It was winter and spring ploughed in strips, the winter ploughing being approximately equally rough after both cotton and fallow. It was planted throughout with cotton, but owing to late planting the growth was poor. The growth of the main axis showed that the best early growth occurred after cotton and winter ploughing, thus confirming the previous season's results. The maximum soil temperatures were, however, lowest on the winter ploughed cotton treatment and there was little difference in the rate of drying after rain.

Again, these results might have been due to positional effects only.

1930-31.—An experiment was laid down with plots of maize, soya beans and fallow, replicated three times in a randomized block layout. At the end of the season each plot was divided into a pair of sub-plots, one of which was winter ploughed and the other spring ploughed. This form of

experiment was necessitated by considerations of space, since more guard rows of cotton must be left between fallowed and cropped plots than between sub-plots having different times of ploughing. Otherwise it would have been preferable to have the six treatments (3 crop treatments $\times$ 2 times of ploughing) completely randomized within each block. The results described below have been tested for significance by the following methods of analysis of variance which will be referred to as Method 1 and Method 2 respectively.

Method 1 is the ordinary method for an experiment with sub-divided plots. It has been described by Yates* and consists of splitting up the total variance into the following parts:—

Variation.	Degrees of freedom with three blocks.
(1) Main treatments (crop)	2
(2) Blocks	2
(3) Main plot error (Crop v. block interaction)	4
(4) Sub-treatments (Time of ploughing)	1
(5) Interaction: sub and main treatments (Ploughing v. crop)... ..	2
(6) Residue—sub-plot error	6
Total	17

(3) is used to test average effect of crop while (6) is used to test average effect of ploughing and the crop v. ploughing interaction. This method has been applied in some cases to sub-plot data for isolated occasions and in some cases to the sub-plot means of several occasions.

Method 2.—In some cases data for the main plots only (means of pairs of differently ploughed sub-plots) were analysed with the inclusion of separate occasions in the scheme of analysis, so as to test the interactions of crop and time effects. The total variance (for main plots) was then split up into:—

Variation.	Degrees of freedom (with 2 blocks and 6 occasions).
(1) Average crop effect	2
(2) Average block effect	1
(3) Average occasion effect	5
(4) Interaction crop v. occasion	10
(5) Interaction block v. occasion	5
(6) Interaction crop v. block	2
(7) Residue (interaction crop v. block v. occasion)	10
TOTAL ...	35

(6) is used as error to test the average effect of crop while (7) is used to test the interactions.

The soya beans had rather a patchy stand, but were otherwise well grown and the maize was a good crop. The fallow was cultivated at the same times as the maize and was kept practically free from weeds.

For the sake of brevity the various treatments will be referred to by letter as below:—

Maize	...	M	Winter Ploughing	...	W
Soya Beans	...	B	Spring Ploughing	...	S
Fallow	...	F			

* J. Ag. Sci. XXIII 1933 pp. 108-145 (see pp. 121-123.)

1931-32.—The W sub-plots were ploughed on 3.9.31, 8-10 inches deep. The F plots had rather more soil moisture than M or B plots (see Table I) but were all fairly dry and ploughed up moderately rough. There was but little difference visible between treatments, the F being if anything very slightly smoother than B or M. The S sub-plots were ploughed on 11-12.11.31, 8-10 inches deep. All treatments were very moist and ploughed smooth but with a fair number of small, wet lumps. A slight shower of rain (0.30 inches) fell on 11.11.31 after some of the ploughing had been done, and the remainder was carried out on 12.11.31. This shower made no appreciable difference to the soil moisture contents at 4-6 inches or 7-9 inches and the style of ploughing after the rain was very much the same as before it, but appeared, if anything, slightly more humpy.

Soil moisture samples were taken at 4-6 inches and 7-9 inches depth at the time of each ploughing. The results for each ploughing separately were tested by a method similar to Method 2 above, except that "depth" replaced "occasion" in the analysis. The data for the W ploughing showed highly significant effects of crop and of depth ($P < .01$ in each case). The interaction crop *v.* depth was quite insignificant, showing that the difference in soil moisture at the two depths was very similar for all crop treatments. The 4-6 inches samples averaged 10.4 % and the 7-9 inches samples 12.3% ($P < .01$). The crop treatment means are shown in Table I.

TABLE I.
SOIL MOISTURE AT TIME OF WINTER PLOUGHING.

Treatment.					Soil Moisture (Means of both depths).		Significant diff. $P = .05$ $P = .01$	
F	...	...	...	...	12.92%			
B	...	...	...	...	10.93%		0.87	1.45
M	...	...	...	...	10.30%			

Significant results :—F > B and M.

The soil moisture data for the S ploughing showed no significant effects at all, either of crop treatment, depth, or interaction between them. The mean soil moisture was 19.6%.

After each ploughing samples were graded by the sieving method. This was carried out as described below for the Time of Ploughing Experiment, except that after the S ploughing the soil was too moist to pass through the $\frac{1}{8}$ -inch sieve. For both W and S ploughing, therefore, the weight of soil passing the $\frac{1}{4}$ -inch sieve was taken as the smallest particle size. In order to make the "surface" figures as comparable as possible with those from the Time-of-Ploughing Experiment, the particles passing the $\frac{1}{4}$ -inch sieve were assumed to have a mean diameter of $\frac{1}{16}$ -inch. The "surface" figures for all sub-plots were tested by Method 1, which showed that there was no significant effect of crop or of crop *v.* time-of-ploughing interaction, i.e., for either time of ploughing the previous cropping had no effect on the roughness of the ploughing as measured. The difference due to time of ploughing was, however, highly significant ($P < .01$), the mean "surface" figures being:— W .. 609; S .. 1005; $P < .01$, i.e., the spring ploughing was much smoother than the winter ploughing. It should be mentioned that the "surface" figures showed no appreciable differences between the S sub-plots ploughed before and after the rain.

The whole experiment was harrowed and planted throughout with U.4/2 (920 S.B.) cotton on 13.11.31. Very poor germination was obtained, probably owing to poor quality of the seed due to the heavy stainer infestation in the previous season. Germination counts were made daily until 23.11.31, when no further improvement in the stand occurred. The counts for this date tested by Method 1 showed no significant effect on germination of previous cropping or of crop *v.* ploughing interaction. The time of ploughing effect was significant ($P < .05$), the mean percentage stands being:— W .. 61.6%; S .. 67.5%; $P < .05$. This effect was doubtless due to the soil moisture difference between W and S, for on 19.11.31 samples 7—9 inches depth, tested by Method 1, showed:— W .. 17.06%; S .. 18.44%; $P < .05$.

There was no significant difference in soil moisture between the crop treatments on this date.

A dust storm occurred on 5.12.31 and many plants were killed, especially on Block III. After 14.12.31 Block III was abandoned for purposes of records and samples owing to its depleted stand, and only Blocks I and II were used.

I. *Plant Samples*.—For purposes of plant sampling each sub-plot was divided into three at right angles to its length. The middle portion equal to half the area was retained for height measurements, yields, etc., and the two end portions were used for plant samples. Samples were taken about twelve days after germination and then fortnightly up to 8.2.32. Up to 28.12.31, ten random plants per sub-plot were taken at each sampling. Thinning was carried out on 30.12.31 and after this only five random plants per sub-plot were taken so as not to deplete the stand too rapidly. The fresh and oven-dry weights were found for the whole plant, and for stem, leaves, squares and bolls separately. In addition, nodes on main stem, leaves, squares, flowers and bolls were counted and the main stem measured, before drying.

1a. *Total Dry Weight*.—The effect of crop treatment on the total dry weight is indicated in Fig. 1. Logarithmic dry weights are plotted in order to facilitate comparison of treatments over the whole period. If the actual values were plotted, the scale would have to be too small for the treatment differences to be visible in the early part of the season. It will be seen that after the first sampling (12 days from germination) the F treatment is consistently lower than the other two. Also that the logarithmic curves are nearly parallel, showing that the treatment differences in terms of actual dry weight are cumulative.

Analysis by Method 1 for the actual dry weights on isolated occasions failed to show any significant effect of treatment even on 14.12.31 with three blocks. This was owing to the small number of plants per sub-plot taken on each occasion, and it was therefore necessary to analyse the variance making use of the data for all occasions in order to reduce the sampling error. As might be expected with actual dry weights ranging from about 1 gramme per 10 plants on 30.11.31 to about 275 grammes on 8.2.32 the variances on the different occasions showed very large differences. The relative variances were nearly constant, however, and the analysis of variance was therefore carried out using for each occasion the logarithms of the dry weights of the sub-plot samples. In the first place Method 1 was applied to the sub-plot means of all occasions, except the first sampling. The average effect of crop

treatment was found to be highly significant ($P < .01$), while the effects of ploughing and of crop *v.* ploughing interaction were quite insignificant. In the second place Method 2 was applied, including *all* the separate occasions. Again the average effect of crop treatment was highly significant ($P < .01$), but the interaction between crop and time was negligible, i.e., there were no significant differences in the relative positions of the crop treatment logarithmic curves on the different occasions. The crop treatment means (all occasions) are shown in Table II.

TABLE II.

Treatment.	Mean logarithmic total dry weight per 10 plants from 30.11.31 to 8.2.32.	Significant	Difference
		P = .01	P = .05
B	2.94	0.11	0.05
M	2.90		
F	2.77		

Significant results : B and M > F.

1b. *Dry Weight of Squares and Flowers.*—The logarithmic dry weights of squares and flowers are shown in Fig. 1. The relative positions of the curves are similar to those for total dry weight, F being lowest throughout.

Method 1 applied to the data for actual dry weight on isolated occasions only showed significance on 8.2.32. The effect of crop treatment was then significant ($P < .05$) while ploughing effect and crop *v.* ploughing were quite insignificant. The crop treatment means are shown in Table III.

TABLE III.

Treatment.	Dry weight squares and flowers per 10 plants on 8.2.32.	Significant	Difference
		P = .01	P = .05
M	25.12 grms.	2.60	1.13
B	23.63 „		
F	17.62 „		

Significant results : M > B > F

In order to utilize the data for all three occasions in the analysis of variance, logarithms of dry weights were used as in the case of the total dry weight. Method 1 was applied to the sub-plot means of all three occasions, and Method 2 to the main plot data, including separate occasions. No significance was found, either for average effects of crop and of ploughing, or for the interactions crop *v.* ploughing and crop *v.* occasion.

Thus the only significant effects of treatment were those of crop at the last sampling. It should be borne in mind that, except on the last occasion, the numbers of squares and flowers in a sample were comparatively small. The presence of one or two large buds or flowers would therefore make a very large percentage increase in the weight of the sample and hence tend to make for large differences between samples of the same treatment. In this connection it should be noted that "number of squares and flowers" showed significant effects of treatment on the earlier occasions (see 1e below).

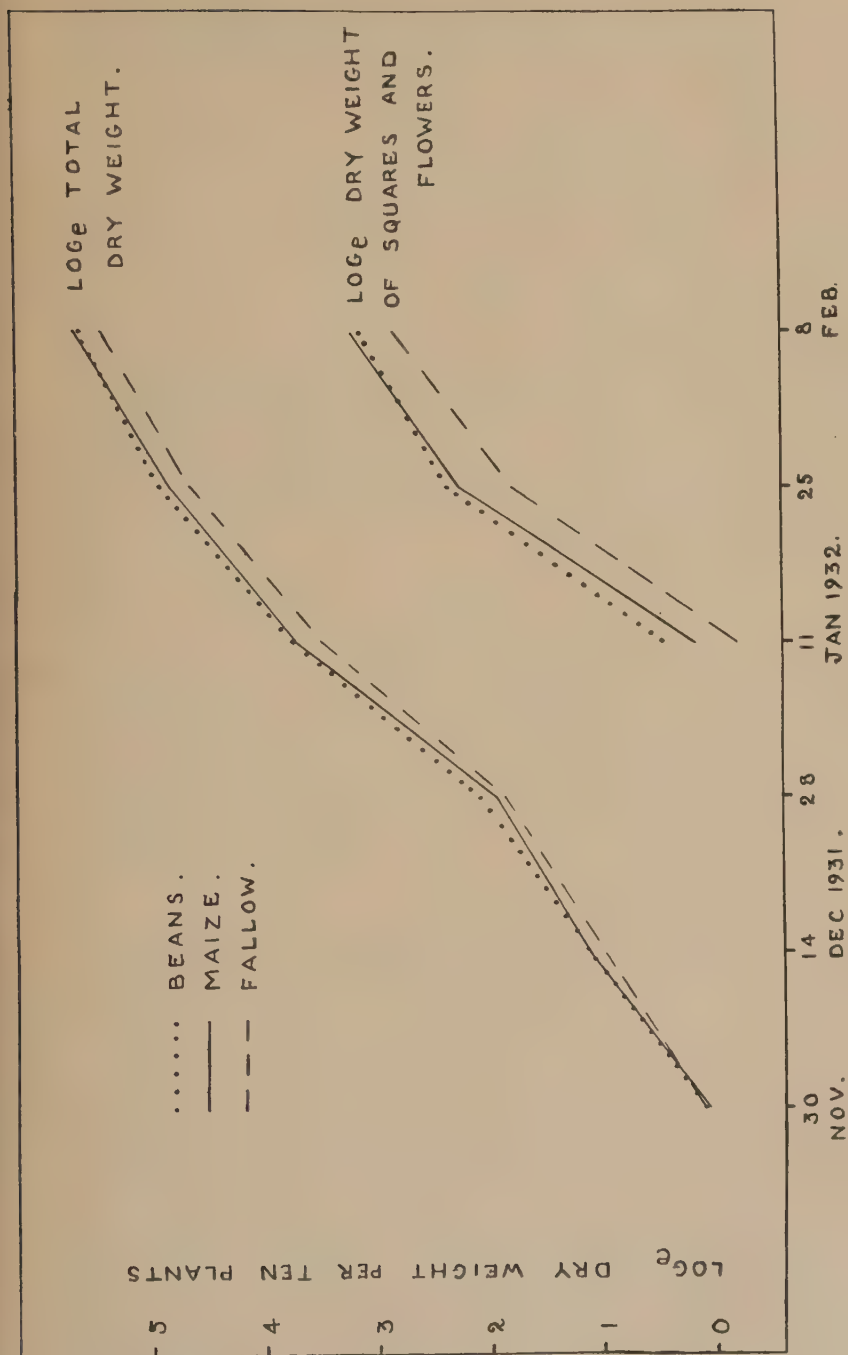


FIG. I. COTTON AFTER FALLOW AND CROP — LOGE TOTAL DRY WEIGHT, AND LOGE DRY WEIGHT OF SQUARES AND FLOWERS.

1c. *Dry Weight of Bolls*.—Only on the last sampling occasion were bolls present on all the sub-plot samples. The differences between treatments were then in the same order as for the squares, viz. $M > B > F$. These differences were, however, very irregular, probably owing to the small number of bolls in each sample, and there was no significant effect of treatment. The numbers of bolls for this occasion also failed to show any significant effect of treatment.

1d. *Nodes on Main Stem*.—The numbers of nodes are shown graphically in Fig. 2. (The cotyledonary node was counted as one). On 30.11.31 there were obviously no significant differences in node number; for the next two occasions M was lower than F, and thereafter it was higher than F. B was consistently highest throughout.

Analysis by Method 1 was carried out for the means of December 14th and 28th (i.e., when M was lowest), for the means of January 11th and 25th and for February 8th. The counts on December 14th and 28th showed no significance either for crop or ploughing effects. For January 11th and 25th crop effect was highly significant ($P < .01$), ploughing effect and interaction crop *v.* ploughing being insignificant. On February 8th crop effect was again very significant (P only slightly $> .01$), ploughing effect and interaction crop *v.* ploughing being insignificant. The crop treatment means are shown in Table IV.

TABLE IV.
NODES ON MAIN STEM PER PLANT.

Treatment.	11.1.32 and 25.1.32.	Significant Difference		8.2.32	Significant Difference	
		P = .01	P = .02		P = .01	P = .05
B	17.45			22.30		
M	17.10	0.35	0.25	21.60	1.24	0.54
F	16.85			20.80		

Significant results: $B > M > F$

$B > M > F$

These differences in node number are very important as they show that after the first six weeks' growth the cotton following fallow had a lower rate of differentiation of parts, in addition to the slower growth in actual size shown by the total dry weights. The importance of rate of differentiation for the production of a fruit bearing "scaffolding" is obvious. It is interesting to find B with significantly more nodes than M, since the only other data found to give a significant difference between B and M (i.e., dry weight of squares and flowers on 8.2.32) give M significantly higher than B. Since the nodes show a significant difference between B and M over three occasions and square weight only on one occasion, this may cast some doubt on the real significance of the B and M difference in square weight.

1e. *Number of Squares and Flowers*.—The numbers of squares and flowers per plant are shown in Fig. 2. F has the lowest number throughout, and M has fewer than B even on 8.2.32 when they were heavier on M than B. The numbers on 8.2.32, however, show no significance, the response on different blocks being very irregular. The means of the other two occasions show a significant effect of crop ($P < .05$); ploughing effect

and crop *v.* ploughing interaction being insignificant. The only definitely significant difference was between B and F, but the difference between M and F nearly reaches the 5 per cent. level of significance. (See Table V.)

TABLE V.

<i>Treatment.</i>	<i>Number of squares and flowers per plant. Means of 11.1.32 and 25.1.32.</i>	<i>Significant Difference P = .05.</i>
B 	16.75	2.79
M 	15.10	
F 	12.50	

Significant result: B > F.

Thus the square numbers confirm the evidence from node numbers that B (and probably M) had a greater rate of differentiation than F, although they afford no definite additional evidence of more rapid differentiation on B than M.

1f. *Moisture Content of Plant.*—It was found, at any rate for the earlier sampling dates, that the moisture content of the whole plant was higher on the S than on the W sub-plots. On the last occasion for which all three blocks were available, *viz.*, 14.12.31, the significance of the moisture content data was tested by Method 1. The ploughing effect was found to be highly significant ($P < .01$), the means being W 81.2 per cent., S 82.8 per cent. Crop effect and crop *v.* ploughing interaction were insignificant. This difference due to ploughing is probably accounted for by the differences in the soil moistures, which on 14.12.31 were W 13.9 per cent., S 15.3 per cent. at 7–9 inches ($P < .02$). But on this date F had a significantly higher soil moisture content at 7–9 inches than B or M (see below). In spite of this the plant moisture content of F was lower than B or M, although not significantly so (see Table VI). It is quite possible that with more efficient plant sampling this crop effect would have been reversed, but it is mentioned as tending to confirm a similar (but significant) difference found in season 1932–33 (see below).

TABLE VI.

<i>Treatment.</i>	<i>Plant moisture content per cent. of fresh weight.</i>	<i>Significance of crop effect.</i>
M 	82.3	P .05
B 	82.1	
F 	81.5	

2. *Height of Main Axis Measurements.*—Beginning on January 2nd, 15 plants on each sub-plot of Blocks I and II were measured weekly throughout the growing period. The plants were selected according to a randomised scheme, but no plants that were next to gaps or topped (*e.g.*, by insect attack) were taken. The same plants were used throughout, except when topping or other damage necessitated changing a plant and then another of as nearly as possible the same height was taken.

The F plants were at first shorter than the B or M plants, but about the end of January they began to grow more rapidly and continued to do so until the end of the growing period. The F plants had a final height of

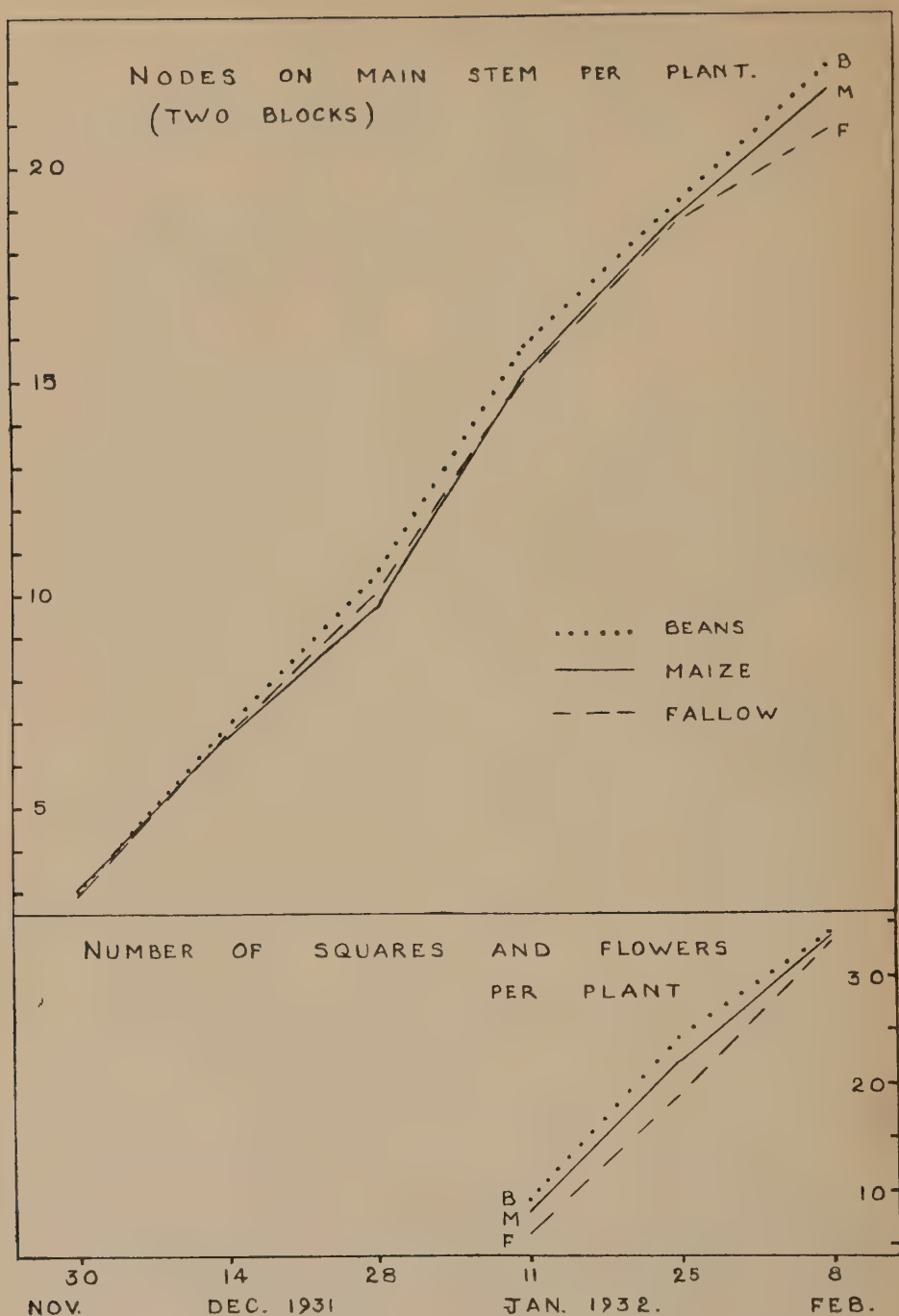


FIG. 2. COTTON AFTER FALLOW AND CROP — NODES ON MAIN STEM AND NUMBER OF SQUARES AND FLOWERS.

95 cms. as compared with 78 cms. for M and 75 cms. for B. Analysis by Method 1 was applied to the final heights, and also to the increments in height for the week when growth was most rapid. No significance was found for crop treatment, ploughing treatment or crop *v.* ploughing interaction. Since the same plants were measured throughout, the sampling error could not be reduced by utilizing data for a number of occasions in testing significance, as was done for the plant sample data. If the difference in height were a real treatment effect, it might be supposed to be due to greater reserves of sub-soil moisture in the F plots. This would have effect during the drought in January and early February.

3. *Soil Compactness*.—Determinations of soil compactness were made on two occasions (11-12.12.31 and 18-19.1.32) on the F and M sub-plots only. The compactness was measured down to a depth of 35 cms. with an apparatus based on those described by Keen and Cashen* and by Balls at the Fifth International Botanical Congress, 1930. The principle is that of a falling weight driving a point into the soil, and the number of impacts necessary per cm. of penetration at any depth gives a measure of the compactness at that depth. It is hoped to describe this apparatus in detail elsewhere. No significant differences between treatments were obtained, soil heterogeneity being very great.

4. *Soil Moisture 7-9 inches Depth*.—At approximately fortnightly intervals up to 20.1.32 samples were taken 7-9 inches for soil moisture determination. Two samples were taken from each sub-plot on each occasion (three on 20.1.32). The results are shown graphically in Fig. 3.

Analysis by Method 1 on isolated occasions only showed a significant effect of crop treatment on two dates (both when soil moisture was low), although ploughing effect was significant throughout. The results for these two occasions are shown in Table VII.

TABLE VII.
SOIL MOISTURE % 7-9" DEPTH.

Treatment.	14.12.31 (3 Blocks).		20.1.32 (2 Blocks).	
	%	Significant Difference $P=.05$.	%	Significant Difference. $P=.05$.
F ...	15.26	0.70	15.95	0.54
B ...	14.54		14.85	
M ...	14.02		14.48	
Significant results : F>B and M			F>B and M	

Analysis by Method 2 for the first three occasions (3 blocks) and also for the last two occasions (2 blocks), showed no significant average effect of crop, nor any significant interaction between crop and occasion. Thus, the 1931-32 data supply no confirmation for the suggestion made in 1929-30 that the soil dries more rapidly after crop than after fallow. If this were the case it should show up in the curves and in the crop *v.* occasion interaction. Possibly this would have occurred had samples been taken

* J. Ag. Sci. XXII. 1932 pp. 126-134.

more immediately after heavy rain, as on such occasions the curves might have been closer together. In any case the results for 14.12.31 and 20.1.32 described above, indicate that by the time the soil moisture has fallen to about 15% the soil that was cropped in the previous season is definitely drier at 7-9 inches than that which was fallowed.

Analysis by Method 1 for the sub-plot means of the first three occasions (3 blocks), and also for the means of the two later occasions (2 blocks), showed in each case a highly significant average effect of ploughing ($P < .01$). Average crop effect and crop *v.* ploughing interaction were not significant. The ploughing means for the first three occasions were: S 17.0%, W 15.4% ($P < .01$) and for the two later occasions: S 16.9%, W 16.0% ($P < .01$). We see then that for the part of the season over which soil moisture was determined (up to the time when the plants were beginning to flower) S was consistently moister at 7-9 inches than W. It seems possible that this is connected with the different roughness of the two ploughings (*cf.* Time-of-ploughing Experiment described below).

5. *Nitrate Content of Soil 7-9 inches Depth.*—Nitrate content was determined on four occasions during the season. A composite sample of four positions (3 on 19.11.31) was taken for each sub-plot. It was air-dried, crushed and sieved 1 mm. Nitric nitrogen in the air-dry soil was determined by the phenol-disulphonic acid method. The results are shown graphically in Fig. 3.

Analysis of variance by Method 1 was carried out for the means of the first two occasions (3 blocks) and also for the means of the last two occasions (2 blocks). In each case the average effects of both crop and ploughing were significant ($P < .05$) but not the interaction crop *v.* ploughing. The treatment means for the two pairs of occasions are shown in Table VIII.

TABLE VIII.
NITRIC NITROGEN AT 7-9" DEPTH.

		19.11.31 and 4.12.31.		1.1.32 and 29.1.32.		
Treatment.	p.p.m.	Significant Difference.		p.p.m.	Significant Difference.	
		P = .05	P = .02		P = .05	P = .02
F ...	40.17			44.38		
B ...	29.60	12.19	16.46	29.45	13.43	21.74
M ...	23.72			22.50		
Significant results : F>M				F>B and M		
W ...	36.01	P<.01		36.47	P<.02	
S ...	26.31			27.75		
Significant results : W>S				W>S		

(*cf.* Time of ploughing experiment described below).

There are no very obvious relations between nitrate and soil moisture. The W sub-plots have higher nitrate and lower soil moisture than the S sub-plots, but among the crop treatments the F plots have the highest nitrate with the highest soil moisture. It is possible that the soil moisture difference accounts for the difference in nitrate between W and S, but

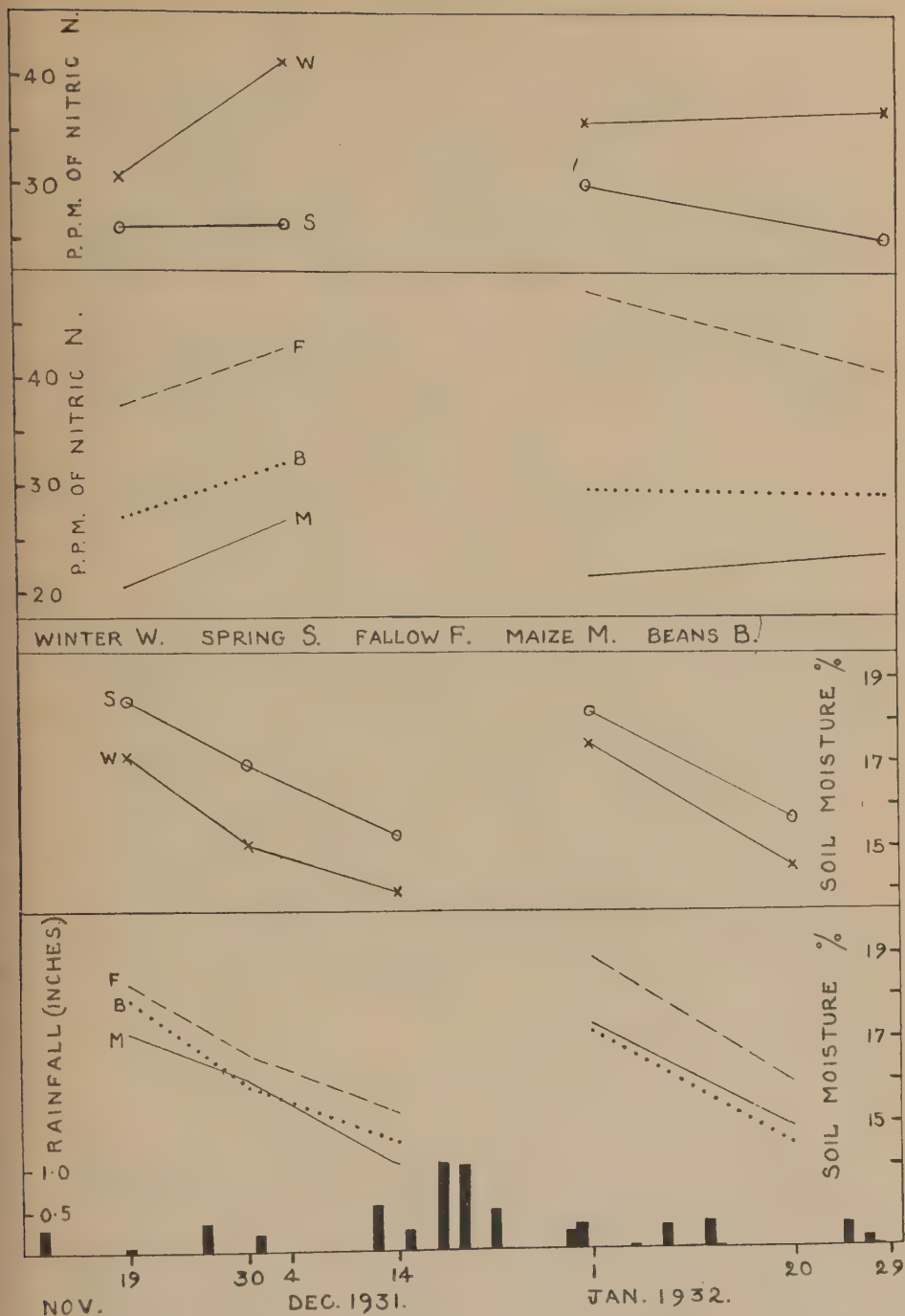


FIG. 3. COTTON AFTER FALLOW AND CROP, WINTER AND SPRING PLOUGHING,— SOIL MOISTURE AND NITRATES 7-9"

that in the crop treatments the soil moisture effect is masked by other effects of crop (*e.g.*, nitrogen depletion of the soil by maize as compared with fallow, or denitrification of soil following the incorporation of maize roots). In any case, it is not definitely established that there was any real difference in the soil moistures of the crop treatments on the dates that the nitrate samples were taken. It seems quite likely that the ploughing effect on nitrate is due, not only to soil moisture differences, which might be assumed to act by affecting aeration, but also to partial sterilization of the soil of the W sub-plots during its exposure in the ploughed state to the early spring sunshine.

Attention may be called to the very high level of nitric nitrogen found on all treatments. This is partly due, no doubt, to the samples being taken 7-9 inches depth, thus omitting the very dry surface layer of the soil which probably has very little nitric nitrogen. Nevertheless, the figures undoubtedly indicate an abundance of nitrate in the soil.

6. *Soil Temperatures. 6 inches Depth.*—At the beginning of the season a soil thermometer was inserted on each of the M and F sub-plots on all three blocks, *i.e.*, 12 in all. These thermometers were special maximum and minimum soil thermometers of the Six's type. They were read daily throughout the season.

The treatment averages showed little or no difference in the minimum temperatures, but in the maximum temperatures the FS average was considerably higher than the other treatments. The responses to treatments on the different blocks were so irregular, however, as to preclude any possibility of significance in the results. As the thermometers were in the same positions throughout, no improvement in significance could be obtained by testing the results over a number of occasions, except in so far as errors in reading might have occurred. It seems obvious that except for detecting very big differences between treatments, a single thermometer per plot (*i.e.*, a single "sample") is entirely inadequate.

Yields.—No yield figures were obtained from this experiment owing to the very poor stand. This was down to 58% on the centre portions which had been reserved for pickings and height measurements.

The bearing of the above results of this experiment are discussed below, together with those of the Time-of-Ploughing Experiment 1931-32 and the Cotton after Fallow and Crop Experiment 1932-33.

Effects of Previous Soil Treatment.

II. Time of Ploughing—Autumn, Winter and Spring.

Experimental.

In addition to the investigation of time of ploughing effect on the experiment I. as described above, a separate experiment having three different times of ploughing was carried out in 1931-32. The three treatments were replicated four times in a randomised block layout.

The results described below have been tested for significance. In most cases the usual method of analysis of variance for a randomised block experiment was applied, either to data for single occasions or to means of several occasions. In some cases, however, Method 2 described above was applied to data for several occasions, so as to test the interactions of treatment and time effects.

The field used was previously under tepary beans which were taken off on 24.3.31. The Autumn plots were ploughed on 29.4.31 with fair moisture, about 2 inches of effective rain having fallen since the removal of the bean crop. The soil ploughed up moderately smooth, there being some large lumps, but the general tilth being fine. The Winter plots were ploughed on 4.9.31 when the soil was very dry (9% soil moisture) and turned up extremely rough and lumpy. (See Fig. 4.) The Spring plots were disc harrowed on 9.10.31 after about an inch of rain and then ploughed. The soil moisture was fairly good down to about 6 inches, but below that depth the soil was very dry. The discing produced 4-6 inches of fine tilt and the ploughing then turned up a fair number of dry lumps from the bottom 3-4 inches. The general roughness of ploughing obtained in this way was very similar to the Autumn ploughing. It should be mentioned that in all three treatments the ploughing depth was 8-10 inches.

The three treatments may be summarised as follows :

- A. Autumn. Smooth ploughing. Exposed in ploughed state for 6 months before harrowing and planting.
- W. Winter. Rough ploughing. Exposed in ploughed state for 2 months before harrowing and planting.
- S. Spring. Smooth ploughing (similar to A), but only exposed in ploughed state for 1 month before harrowing and planting.

After each ploughing, samples were graded by a sieving method essentially the same as that described by Keen*. In the present case, however, six sieves were used instead of four and the larger lumps were also graded. A nest of six sieves and a base box were made, the meshes used being $\frac{1}{8}$ -inch, $\frac{1}{4}$ -inch, $\frac{1}{2}$ -inch, 1-inch, 2-inches and 3-inches. Wire netting was used for the four larger meshes, square mesh steel screening for the $\frac{1}{4}$ -inch mesh, and square mesh phosphor bronze wire gauze for the $\frac{1}{8}$ -inch mesh. Three random samples were taken on each plot, each sample being taken down to ploughing depth over an area 15 inches square. Lumps partly in the square were included in the sample if judged to be more than half in it. Each sample was sieved and the soil retained by each sieve weighed. Before weighing the lumps retained by the 3-inch mesh, they were further graded on a V-shaped wooden grader marked in inches. Three measurements at right angles were made on each lump and the mean taken as its diameter.

Samples taken from each fraction showed the differences in moisture content to be negligible, so no correction was made for this.

The results of the sieving and grading tests are shown graphically in Fig. 5. It will be seen that the percentages of different sized lumps are very similar in the A and S treatments, whereas the W treatment has a much larger percentage of soil in large lumps and a correspondingly small quantity in fine particles. In order to examine the results statistically, use was made of the "surface" figure (see Keen's papers quoted above). This is an estimate of the combined surface area of all the lumps in the sample. It is calculated on the assumption that all the lumps on any one sieve are spheres of an average diameter mid-way between that sieve aperture and the next larger one. To the smallest particles (passing the $\frac{1}{8}$ -inch sieve) a

* J. Ag. Sci. XX 1930, pp. 364-389 and Emp. J. Exp. Ag. I 1933, pp. 97-102.



FIG. 4. TIME OF PLOUGHING EXPERIMENT.
ROUGH WINTER PLOUGHING.

(Note the foot rule.)

diameter of $\frac{1}{16}$ -inch was given. Analysis of variance carried out on these "surface" figures showed a highly significant effect of treatment ($P < .01$). The treatment means are shown in Table IX.

TABLE IX.

Treatment.	Surface.	Significant Difference.	
		P = .05	P = .01
S	820	164	248
A	757		
W	459		

Significant results : W rougher than S and A.

The W plots were disc-harrowed on 10.10.31. This reduced the lumps to about the size of those on the A plots though they were more numerous on the W plots. The whole field was disc-harrowed on 6.11.31, and on 13.11.31 after good rains it was harrowed and planted all through with U.4/2 cotton. There were then no obvious differences visible between treatments, either in tilth or soil moisture.

Nearly full stands were obtained (mean 91%). Germination counts failed to show any significant effects of treatment, although in the actual counts the W plots were lowest.

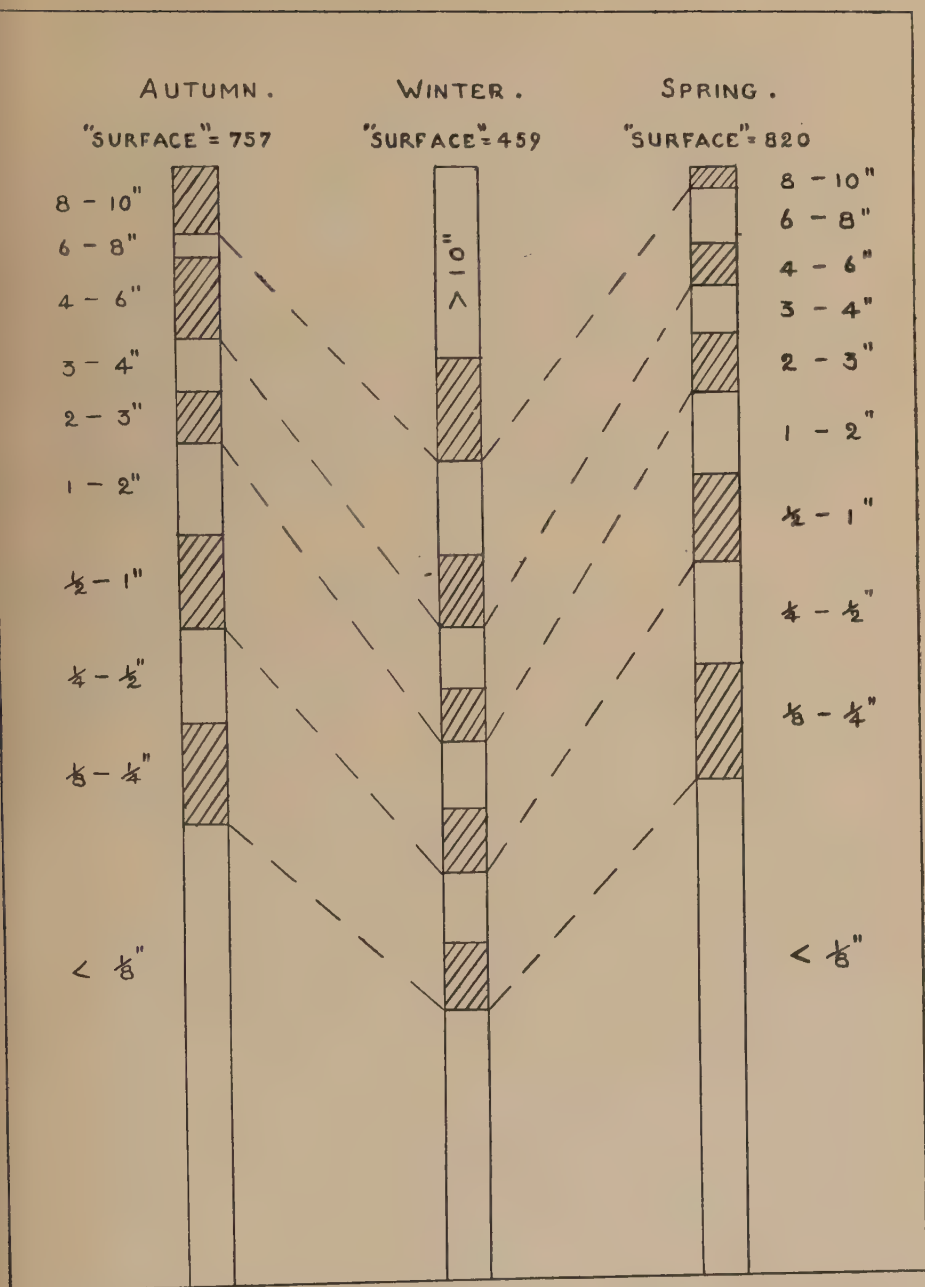


FIG 5. AUTUMN WINTER AND SPRING PLOUGHING
 — PERCENTAGE (BY WEIGHT) OF LUMPS FROM
 Sieving Tests.

The dust storm on 5.12.31 caused a good deal of leaf scorch, but did much less damage than on other parts of the farm.

The following records and observations were made during the season :—

1. *Plant Samples*.—Plant sampling was carried out fortnightly, from one week after germination until 16.3.32, as described for the experiment on cotton after fallow and crop. Ten random plants per plot were taken at each sampling before thinning (30.12.31) and five after thinning. The sample plants were examined as described above.

1a. *Total Dry Weight*.—The logarithms of the total dry weights are shown in Fig. 6. It will be seen that the W plants started lower than the A or S, and also that after 9.12.31 (3 weeks from germination) the A plants went ahead and remained largest for the rest of the period sampled.

Analysis of variance was carried out for the actual dry weights on isolated occasions up to and including 23.12.31 (10 plants per plot), and thereafter on means of pairs of adjacent occasions (5+5 plants per plot). The response to treatment on different blocks was very irregular and a significant effect of treatment ($P < .05$) was only found for November 25th and 6th and January 20th. The treatment means are shown in Table X.

TABLE X.
TOTAL DRY WEIGHT PER PLANT.

Treatment.	25.11.31.			6.1.32 and 20.1.32.		
	Mgm.	Significant Difference		Grms.	Significant Difference	
		P = .05	P = .02		P = .05	P = .02
A	84.1			8.94		
W	66.8	12.8	16.5	5.93	2.22	2.85
S	75.4			5.57		

Significant results: A > W

A > W and S.

In order to utilize the data for a number of occasions, in the analysis of variance, logarithms of the dry weights were used. Method 2 was applied to the log. dry weights for all occasions except the first, which had to be omitted as its relative variance was much smaller than that on the subsequent occasions. The average effect of treatment just failed to reach the conventional 5% level of significance (Z found 0.799; Z required 0.819) owing to the very irregular response on different blocks. This irregularity was demonstrated by the fact that treatment *v.* blocks interaction was very significant ($P < .01$). The interaction of treatment and occasion was absolutely insignificant, showing that the treatment log. curves maintained the same positions relative to each other throughout the period. Applying Fisher's *t* test to the treatment means, A was found to be significantly higher than S (see Table XI), and comparing A with the mean of W and S the difference was also found to be significant ($P < .05$). These results should perhaps be accepted with a certain amount of caution as the average treatment effect just failed to reach the $P = .05$ level, but they are certainly very strongly suggestive of a real effect of A.

TABLE XI.
MEAN LOG_e TOTAL DRY WEIGHT PER 10 PLANTS FROM 9.12.31 to 16.3.32.

Treatment.	Log. dry weight.	Significant difference P = .05.
A	4.501	
W	4.308	
S	4.239	0.212

Significant result: A > S.

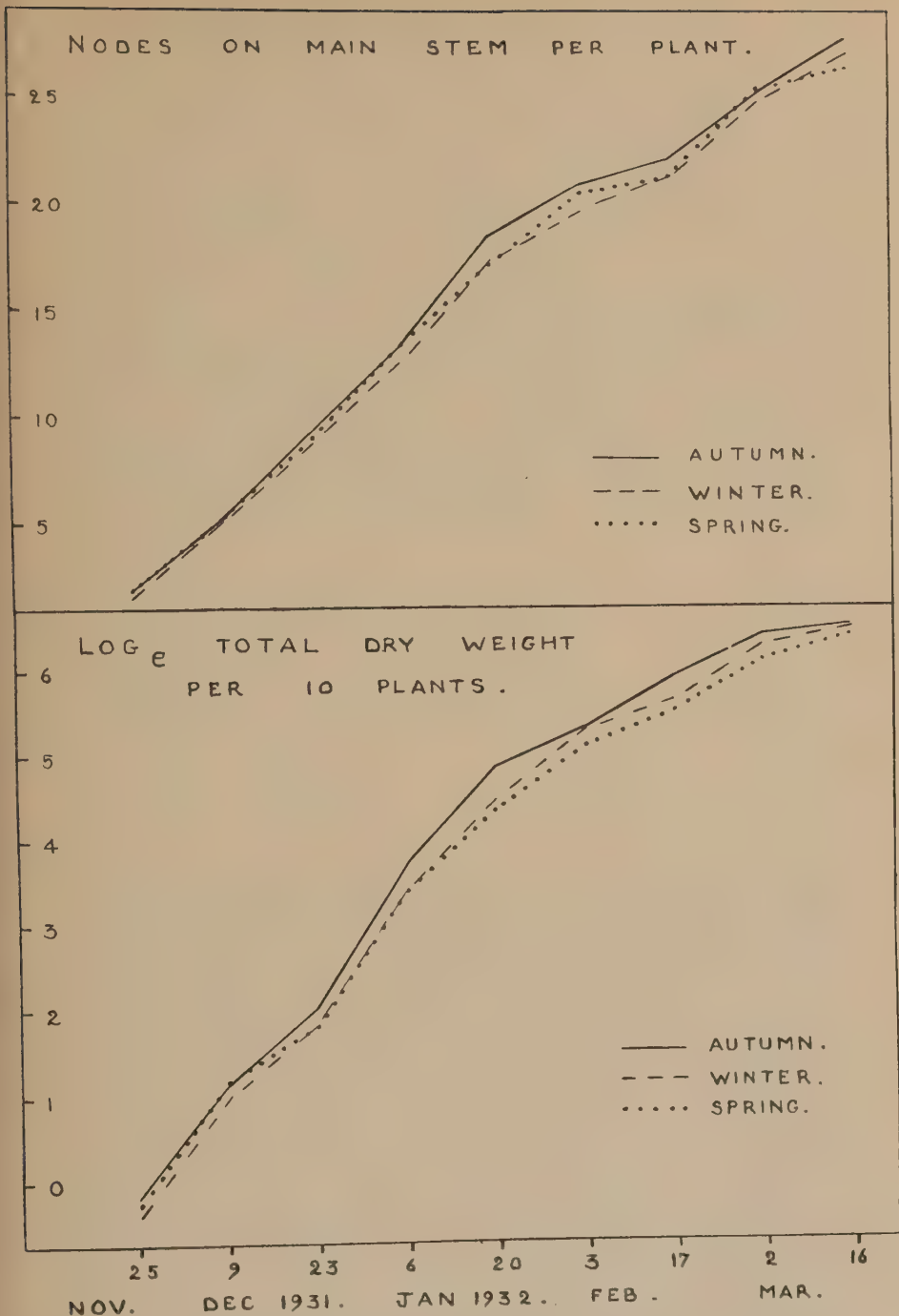


FIG. 6. COTTON AFTER AUTUMN WINTER AND SPRING PLOUGHING — LOG_e TOTAL DRY WEIGHT AND NODE NUMBER.

The lack of difference in total dry weight between W and S confirms the results of the cotton after fallow and crop experiment.

1b. *Dry Weight of Squares, Flowers and Bolls.*—The treatments showed but little difference in respect of dry weight of squares and flowers. For dry weight of green bolls the differences in the treatment means were comparatively large (with $A > W > S$), but the response to treatment on different blocks was so irregular as to preclude any possibility of significance. This was the case even on the last two occasions, when the number of bolls per plant was reasonably high (mean number 15.7). This irregularity and consequent lack of significant treatment effect on fruiting is also shown by the final yields (see 3 below).

1c. *Nodes on Main Stem.*—The numbers of nodes are shown graphically in Fig. 6. It will be seen that, as in the log. total dry weight curves, W starts lower than the others and A goes ahead after 9.12.31.

Analysis of variance was carried out for isolated occasions up to 23.12.31 and also for the mean of the last six occasions. Effect of treatment was significant on 25.11.31 ($P < .05$) and also for 6.1.32 to 16.3.32 ($P = .01$). The treatment means for these dates are shown in Table XII.

TABLE XII.
NODES ON MAIN STEM PER PLANT.

Treatment.	25.11.31.		6.1.32—16.3.32.		
	Nodes.	Significant Difference $P = .01$.	Nodes.	Significant Difference	
				$P = .05$	$P = .01$.
A	1.78	0.30	21.30	0.48	0.72
S	1.78		20.79		
W	1.48		20.46		

Significant results : A and $S > W$

$A > S$ and W.

The low node number on W a week after germination and its low total dry weight at the same time, may have been due to the fact that there was less soil moisture than on A and S (see below). In the latter part of the period sampled, A was definitely ahead in the matter of node number. This suggests that it should have produced a better crop, but as mentioned above (1b) the fruiting data showed no significance, although A was ahead of W and S in the figures obtained. The lack of difference in node number between S and W (except on 25.11.31) confirms the results of the cotton after fallow and crop experiment.

2. *Height of Main Axis Measurements.*—Beginning on December 18th, ten plants per plot were measured weekly throughout the growing season. This was carried out as in the case of the cotton after fallow and crop experiment described above.

The A plants were taller throughout, but there was very little difference between W and S although the latter went ahead somewhat at the end of the growing period. Analysis of variance for height was carried out for 26.2.32, when there was no difference in height between S and W; and also for the final date (15.4.32) when S had gained considerably on W. A significant effect of treatment was found on 26.2.32 but not for the final heights on 15.4.32. The treatment means for the former date are shown in Table XIII.

TABLE XIII.
HEIGHT OF MAIN AXIS ON 26.2.32.

Treatment.	Cms.	Significant Difference P = .05.
A	58.5	8.2
W	48.8	
S	48.7	

Significant results: A > W and S.

3. *Yields of Seed Cotton.*—A single picking was taken (from the centre portions of the plots) on 27.5.32 by which time most of the bolls had opened. This picking was made on 100 plants selected from each plot. The yields were in the order A > W > S, but showed no significant effect of treatment, the response on different blocks being very irregular.

4. *Soil Moisture 7-9 inches Depth.*—Samples for soil moisture were taken at intervals up to the end of January, and one set was taken on 4.3.32 after heavy rains. Two samples per plot were taken on each occasion. Results are shown graphically in Fig. 7.

Analysis by Method 2 for all the occasions showed no significant *average* effect of treatment. All the interactions, including treatment *v.* occasion, were highly significant ($P < .01$). The treatment means for each occasion are shown in Table XIV.

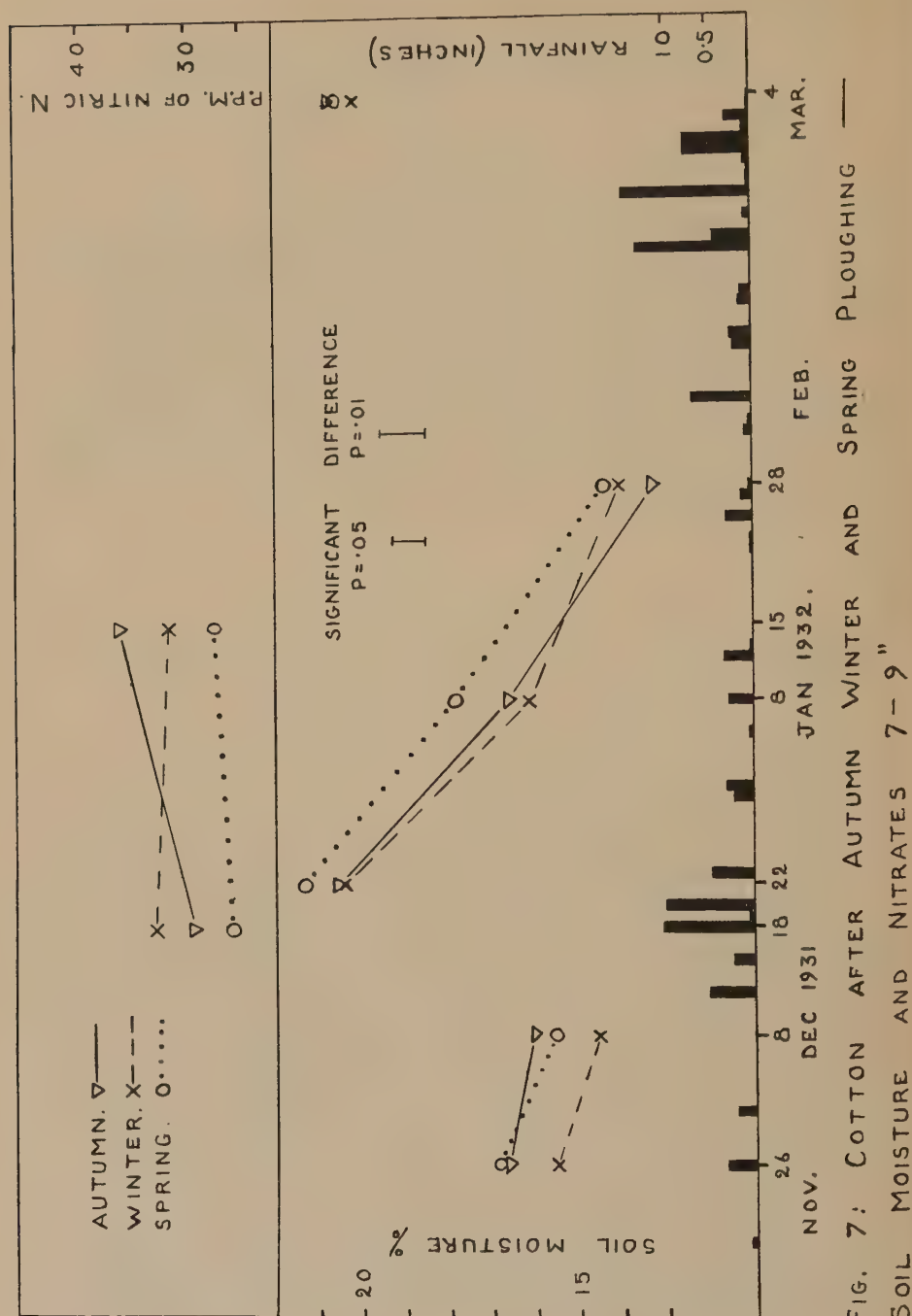
TABLE XIV.
SOIL MOISTURE % 7-9" DEPTH.

Treatment.	26.11.31.	8.12.31.	22.12.31.	8.1.32.	28.1.32.	4.3.32.	Significant Difference	
							P = .05	P = .01
A ...	16.65	16.05	20.58	16.63	13.25	20.68	0.78	1.05
W ...	15.53	14.53	20.43	16.15	14.05	20.18		
S ...	16.88	15.55	21.35	17.88	14.40	20.58		
Significant Results:	A and S >W	A and S >W	S> W and A	S> W and A	S and W >A	...		

The consistently higher soil moistures on S than W found for all the sampling dates before 28.1.32, confirmed the similar results from the cotton after fallow and crop experiment. The treatment differences in soil moisture, at least at the beginning of the season, appear to be connected with the roughness of ploughing: for the rough ploughed W is drier at 7-9 inches than the smooth ploughed S and A, although the S and A were exposed in the ploughed state for one and six months respectively and the W for two months. It is difficult to account for the fact that on and after 22.12.31 A is drier than S. It might be supposed that this was due to the greater growth of cotton on the former (*cf.* total dry weights 1a above), but this would not explain the difference on 22.12.31 when the soil was practically saturated after 2 inches of rain. The difference on this date, however, barely reached the $P = .05$ level. In order to complete the picture of the soil moisture changes, deeper samples as well as those at 7-9 inches would be desirable.

5. *Nitrate Content of Soil 7-9 inches Depth.*—Nitrate content was determined twice during the season. Composite samples (each of four positions per plot) were taken on 18.12.31 and again on 15.1.32, and the nitric nitrogen determined as described for the cotton after fallow and crop experiment. The results are shown in Fig. 7.

Analysis of variance by Method 2 showed a highly significant average



treatment effect ($P < .01$), but no significant interaction "treatment *v.* occasion." The treatment means for the pair of occasions are accordingly presented in Table XV.

TABLE XV.
NITRIC NITROGEN AT 7-9" DEPTH. MEANS OF 18.12.31 AND 15.1.32.

Treatment.	<i>p.p.m.</i>	Significant Difference	
		P = .05	P = .01
A	33.06		
W	32.46	2.40	3.63
S	26.86		

Significant effect : A and W > S.

The lower nitrate content on S than W confirms the similar results found on the cotton after fallow and crop experiment, and as in the case of the ploughing treatments on that experiment, low nitrate is here associated with high soil moisture. Also it should be noted that those treatments which had longer exposure in the ploughed state (A and W) had the higher nitrate contents. This tends to support the suggestion made above, that partial sterilization of the soil during exposure in the ploughed state plays a part in determining the amount of nitrification.

The bearing of the results of this experiment are discussed below together with those of the experiments on cotton after fallow and crop with two times of ploughing.

Effects of Previous Soil Treatment.

III. Cotton after Fallow and Crop. Autumn and Spring Ploughing.

Experimental.

1931-32.—In season 1931-32 an experiment was laid down consisting of eight randomised blocks of maize, soya bean and fallow plots. After the crops had been taken off, each plot was divided into a pair of sub-plots, one of which was autumn ploughed and the other spring ploughed. The large number of blocks was rendered possible by the use of a caterpillar tractor for ploughing. This could turn with a two-furrow plough in a 20-foot pathway, and it was therefore possible to have two rows of 85-foot plots separated by such a pathway in each of two fields 190 feet wide. The results given below have been tested by the method of analysis of variance described as Method 1 above.

The maize had a good stand and grew well, but the beans had a distinctly poor stand. The fallow plots were cultivated at the same times as the maize plots and were kept practically free from weeds.

The treatments will be referred to by the letters shown below :—

Cotton following :

Maize	...	...	M	Autumn ploughing	...	A
Soya beans	...	...	B	Spring ploughing	...	S
Fallow	...	...	F			

1932-33. The A sub-plots were ploughed on 23-24.5.32, 8-10 inches deep. The soil moisture, 7-9 inches depth, at the time of A ploughing showed no significant effect of fallow or crop, and the mean was 18.1%. The ploughing on all plots was fairly smooth, if anything the M plots appearing slightly rougher than the B, and the B slightly rougher than the F. The S sub-plots were ploughed on 2-3.11.32, 8-10 inches deep, with

good moisture. The soil turned up with an appreciably smoother tilth than at the time of A ploughing. There were no very noticeable differences in roughness between the M, B and F plots.

The whole experiment was harrowed and planted throughout with U.4/2 (920 S.B.) cotton on 10.11.32. Germination was at first poor and counts on 22.11.32 showed a mean stand of 49%. There was no significant effect on germination of either crop or time-of-ploughing treatment in spite of higher soil moisture on A than S (see below). 0.86 inches of rain fell on 25.11.32 and a second germination occurred. On 28.11.32 germination counts showed that the mean stand had now improved to 88%, effects of treatment still being insignificant.

A hail storm on 15.12.32 completely ruined the experiment. The results obtained before the hail, as well as some soil examinations carried out afterwards, are described below.

1. *Plant Samples*.—Five random plants per sub-plot were taken on six of the eight blocks on 30.11.32 and again a fortnight later (14.12.32). Plants of the first and second germinations were included just as they chanced to be taken. The sample plants were examined as described above. No significant effect of crop or ploughing treatment was found for the first sampling, either for total dry weight or node number. The results of the second sampling are given below.

1a. *Total Dry Weight*.—The total dry weights on 14.12.32 showed a highly significant effect of crop treatments ($P < .01$), but no significance of ploughing or crop *v.* ploughing interaction. The crop treatment means are shown in Table XVI.

TABLE XVI.

Treatment.	Total dry weight per plant 14.12.32.	Significant Difference.	
		P = .05	P = .01
M	0.376 grms.	0.057	0.082
B	0.267 "		
F	0.221 "		

Significant results : $M > B$ and F .

The above treatment differences were not due to differences in percentage of first germination plants, for the germination counts showed F with a higher percentage of first germination plants than M, though not significantly so. The small difference between B and F may probably be attributed to the very poor stand of soya beans in 1931-32.

1b. *Nodes on Main Stem*.—The node numbers on 14.12.32 showed a highly significant effect of crop treatment ($P < .01$), but the effects of ploughing and crop *v.* ploughing interaction were insignificant. The crop treatment means are shown in Table XVII.

TABLE XVII.

Treatment.	Nodes per plant 14.12.32.	Significant Difference	
		P = .05	P = .01
M	6.07	0.44	0.63
B	5.42		
F	4.98		

Significant results : $M > B > F$.

The significantly higher rate of differentiation after crop than after fallow is here showing up very early in the season (about three weeks after germination).

1c. *Moisture Content of Plant.*—The moisture contents of the whole plants on 14.12.32 showed a highly significant effect of crop treatment ($P < .01$), but ploughing effect and crop *v.* ploughing interaction were quite insignificant. The crop treatment means are shown in Table XVIII.

TABLE XVIII.

Treatment.	Plant moisture content % of fresh weight 14.12.32.	Significant Difference	
		P = .05	P = .01
M	85.01		
B	83.84	0.66	0.93
F	83.87		

Significant results : M > B and F.

The higher moisture content of the M plants was not apparently due to higher soil moisture, for on 6.12.32 there was no significant difference in soil moisture at 7–9 inches. (The actual data on 6.12.32 showed a higher soil moisture content on F than on M and B.)

2. *Soil Moisture 7–9 inches Depth.*—Samples were taken on five of the eight blocks on three occasions (24.11.32, 29.11.32 and 6.12.32), a composite sample of two positions being taken from each sub-plot. A significant effect of treatment was only found for 24.11.32 when the soil moisture content was fairly low. On this occasion the time of ploughing effect was highly significant ($P < .01$); the means being A, 15.6%, S, 14.4%. There was no significant crop effect or crop *v.* ploughing interaction.

3. *Soil Compactness.*—Determinations of soil compactness were made on 30.12.32 on all the F and M sub-plots of four blocks. The measurements were carried out down to a depth of 35 cms. as in the case of the 1931–32 experiment (*q.v.*). Down to 20 cms. depth no significant effect of treatment was found, although the crop effect at 15–20 cms. (*i.e.*, just above the bottom of the ploughing) approached the 5% level of significance. At this depth M was slightly less compact than F. At the bottom of the ploughing, 20–25 cms. depth, the average crop effect practically reached the $P = .05$ level (Z found 1.156; Z required 1.158). At this depth the mean numbers of impacts per cm. of penetration were:—M 0.64; F 0.72; $P = .05$ (nearly). *i.e.*, M was less compact than F. At 25–30 cms. depth, just below the ploughing, there was no significant *average* effect of treatment, but a significant interaction crop *v.* ploughing was found ($P < .05$). This interaction took the form of a reversal of the ploughing effect after the two different crop treatments, *i.e.*, on the M plots A was softer than S. but on the F plots the reverse was the case. A similar interaction crop *v.* ploughing ($P < .01$) was found at 30–35 cms. depth. The sub-treatment means are shown in Table XIX.

TABLE XIX.
SOIL COMPACTNESS 30.12.32. MEAN NUMBER OF IMPACTS PER CM. PENETRATION.

Depth cms.	Sub-treatment.	Impacts/cm.	Sub-treatment.	Impacts/cm.	Significant Difference	
					P = .05	P = .01
25-30... ..	MA	1.20	FA	1.92	0.41	0.62
	MS	1.63	FS	1.53		
Significant results : MA softer than MS. FS softer than FA (?).						
30-35... ..	MA	2.49	FA	3.44	0.64	0.97
	MS	3.69	FS	2.71		

Significant results : MA softer than MS. FS softer than FA.

NOTE.—Owing to the design of the experiment, MA cannot be compared with FA nor MS with FS by means of the above “significant differences” which are found from the sub-plot error.

It is difficult to explain this reversal of the ploughing effect on M and F, especially in the absence of data as to penetration of moisture to below ploughing depth on the different treatments.

The results at 20–25 cms. indicate fairly definitely that at the bottom of the ploughing M was less compact than F. It should be remembered that these determinations were carried out after the soil had been beaten down considerably by the hail and heavy rain on 15–16.12.32. Before that time there may well have been greater differences in compactness between the treatments.

4. *Nitrate Content of Soil 7–9 inches Depth.*—Nitrate content was determined, as described for the 1931–32 experiment, on samples taken 3.2.33. A composite sample of five positions was taken for each sub-plot over three blocks. The results showed a significant effect of crop treatment ($P < .01$) and of ploughing ($P < .05$), but no significant crop *v.* ploughing interaction. The treatment means are shown in Table XX.

TABLE XX.
NITRIC NITROGEN AT 7–9" DEPTH. 3.2.33.

Treatment.	p.p.m.	Significant Difference	
		P = .05	P = .01
F	35.18	5.39	8.93
B	29.82		
M	23.35		
Significant results : F and B>M. F>B (?)			
A	35.03	11.07	
S	23.87		

Significant results : A > S.

The difference between F and B practically reaches the conventional 5% level of significance. These results confirm those of 1931–32, except that in that season no significant difference was found between B and M. In 1931–32 the treatments maintained approximately the same relative positions in respect of nitrate content on all the sampling dates. It seems most probable, therefore, that the above results for 3.2.33 may be taken to apply approximately to the period before the hail storm.

The bearing of the results of this experiment is discussed below.

Effect of Previous Soil Treatment.

Effects of Previous Fallow and Crop, and Time of Ploughing.

DISCUSSION.

It must be admitted at the outset that as yet no satisfactory explanation of the depressing effect of fallow has been found. Most of the evidence so far collected is negative in character. That the effect exists is well proven, both by numerous field observations at Barberton and Bremersdorp, and by the results of the experiments described above. These results show that previous fallow has an adverse effect on the early growth of cotton, not only in respect of actual

size (total dry weight) but also rate of differentiation (node number, square number) and flower bud formation (square number, square dry weight).

It was suggested in 1929-30 that the relatively fine ploughing tilth obtained on fallowed as compared with cropped land might be the main factor. The experimental evidence obtained in 1931-32 is opposed to this suggestion. In the experiment on cotton after fallow and crop with Winter and Spring ploughing, for 1931-32, there was no significant difference in the ploughing tilth after the fallow, beans and maize for either time of ploughing. In spite of this the fallow treatment had a significantly depressing effect on the early growth and development of the cotton plants. Furthermore, the Spring ploughing was much less rough than the Winter ploughing, but time of ploughing had no significant effects on the cotton plants, except as regards germination and plant moisture content. (Both these were probably due to the higher soil moisture content of the Spring ploughed sub-plots.) The results of the time-of-ploughing experiment confirm these indications that, at least in 1931-32, roughness of ploughing was not an important factor at Barberton. In that experiment the Winter ploughing was very much rougher than the Spring ploughing, but there was no significant difference between these two treatments as far as growth and earliness of the plant were concerned. (An exception to this statement occurred a week after germination, when the plants on the Spring ploughed treatment had a higher node number than those on the Winter ploughing. This was probably due to the higher soil moisture content giving the plants a better start on the Spring ploughed plots.) Although the Autumn and Spring ploughing were of a similar tilth and Winter ploughing much rougher, the plants on the Autumn ploughed plots made significantly better growth than on either of the other two treatments.

The preliminary results in 1929-30 suggested that there might be an effect on cotton of the interaction of previous crop and time of ploughing. The interaction indicated was a greater beneficial effect due to maize when combined with Winter ploughing. The results of the experiments for 1931-32 and 1932-33 have shown no significant interactions of crop and ploughing effects on the cotton, although the design of the experiments was well adapted to detect accurately such interactions.

The very high level of nitric nitrogen found on all treatments of the experiments in 1931-32 and 1932-33, suggests that at Barberton soil nitrate is not likely to be a limiting factor for the growth of cotton. This is borne out by the negative results of nitrate applications in

fertilizer experiments. If the concentration of soil nitrate is concerned at all in the depressing effect of previous fallow, there must be an adverse effect of high nitrate content, for the fallowed plots always had very much higher nitrate contents than the crop plots. Indications of an adverse effect on sorghum of high nitrate content were found by Hartley and Greenwood* in Nigeria. They noted that it was not accompanied by the excessive vegetative growth usually associated with too much nitrogen. In this connection it should be pointed out that the cotton following fallow made *less* vegetative growth in the early part of the season than that following maize, and that in spite of the higher soil nitrate it was actually less succulent (as shown by the plant moisture contents in 1932-33 and possibly in 1931-32). It seems however, very improbable that an adverse effect of high nitrate content can be the explanation of the depressing effect of fallow. If this were so the Winter ploughed fallow (1931-32) and Autumn ploughed fallow (1932-33), having far higher nitrate contents, should have had much poorer early growth than the Spring ploughed fallow. Actually the differences between growth on Winter and Spring ploughed fallow (1931-32), or between growth on Autumn and Spring ploughed fallow (1932-33), were small and quite insignificant. The evidence from the time-of-ploughing experiment (1931-32) is also opposed to the hypothesis of an adverse nitrate effect, for the Autumn ploughed plots had both better growth and higher nitrate than the Spring ploughed plots. The evidence obtained from these experiments leads therefore to the conclusion that the depressing effect of fallow on early growth of cotton is not due to soil nitrate content, and that the latter is not an important factor for growth of cotton at Barberton.

A possible hypothesis is that the better growth of cotton on cropped than on fallowed land is due to better penetration of moisture and better aeration in the former. No definite evidence has as yet been obtained to support this suggestion, but it is quite conceivable that the roots of the previous crop might have the effect of making the soil more porous. If this were the case, rainfall would penetrate to lower levels on the cropped land. The total soil moisture available to the plant would then be greater (owing to less surface loss), although as was found in 1931-32 the moisture content at 7-9 inches depth might be less than on fallowed land. This might account for the better growth and higher plant moisture content of cotton following maize than cotton following fallow. More soil nitrate would be carried down to lower levels on the cropped land, thus partially accounting for the lower nitrate content found at 7-9 inches depth. If the soil were

* Emp. J. of Exp. Ag. I., 1933, pp. 113-121.

really more porous after crop than after fallow, soil compactness determinations might be expected to show the cropped land less compact than the fallowed land. In 1932-33 indications of such differences were found, even after the soil had been beaten down by hail and heavy rain. It is hoped to obtain evidence for or against the above hypothesis in the coming season, by means of soil samples for moisture and nitrate contents taken at various depths on the Rotation Experiment described below, and also by means of compactness tests on the same experiment.

The results of the time-of-ploughing experiment in 1931-32 showed on the whole better plant development (total dry weight, node number and height) after Autumn ploughing than after Winter or Spring ploughing. This superiority did not show up significantly in the yields, but it seems quite possible that it might have done so had a more uniform field been used. The lack of difference found between Autumn and Spring ploughing treatments in the early samples from the cotton after fallow and crop experiment in 1932-33, was quite in agreement with the results of the time-of-ploughing experiment 1931-32. In the latter experiment the difference between cotton after Autumn and Spring ploughing did not show up until 5 weeks from germination. Neither of the experiments in 1931-32 showed any significant difference between Winter and Spring ploughing as far as growth of cotton was concerned, apart from the single exception previously noted. Thus the evidence from the experiments described above for 1931-32 shows a beneficial effect on the cotton plant of Autumn ploughing, but no difference in the effects of Winter and Spring ploughing.

Effects of Previous Soil Treatment.

IV. Rotation Experiments.

In season 1932-33 a rotation experiment, which is to be carried on over a number of years, was laid down on the loam. The treatments are: cotton following cotton, sunflowers, maize, soya beans, tepary beans and fallow respectively in a 2-year rotation. There are two "sub-experiments":—*a* and *b*. Sub-experiment *a* was planted with cotton throughout in 1932-33, and will have the six rotation crop treatments for 1933-34, while *b* had the six treatments in 1932-33 and will be entirely under cotton for 1933-34. In each sub-experiment the six treatments are repeated six times in a randomized block layout. The same plots are being retained for the same rotation crop treatments throughout the duration of the experiment, so that after a number of years it will be possible to assess the effect of continuous cotton, cotton alternating with sunflowers, etc.

A similar rotation experiment, having 4 blocks per sub-experiment instead of 6, was laid down on the granite soil in 1932-33.

Although these rotation experiments are only in their initial stages, some results of soil examinations made on sub-experiment *b* (loam) at the end of season 1932-33, may be presented as they seem to be of immediate interest.

1. *Soil Moisture Content*.—At the beginning of June, 1933, after the removal of all the rotation crops except cotton (which had ceased growth), samples were taken for soil moisture at one-foot intervals down to a depth of five feet. This was done on all the plots of three blocks, each sample being a composite of two positions on the plot. The results were tested by a method of analysis of variance similar to Method 2 (above), the total variance being split up as follows:—

Variation.								Degrees of Freedom.	
(1) Treatment	...	...	...	...	...	...	...	5	
(2) Depth	...	...	...	...	...	...	...	4	
(3) Block	...	...	...	...	...	...	...	2	
(4) Interaction depth v. treatment	...	...	...	...	...	...	...	20	
(5) Interaction depth v. blocks	...	...	...	...	...	...	...	8	
(6) Interaction treatment v. blocks	...	...	...	...	...	...	...	10	
(7) Residue (interaction depth v. treatment v. blocks)	...	...	...	...	...	...	...	40	
TOTAL								89	

(6) is used as error to test the average effect of treatment, (5) to test the average effect of depth, and (7) is used to test the interactions. The average effects of treatment and depth, and the interaction depth v. treatment were all found to be highly significant ($P < .01$). The average treatment effects (means of all five depths) are shown in Table XXI.

TABLE XXI.
SOIL MOISTURE CONTENT % AT END OF SEASON. MEANS 1-5' DEPTH.

Fallow.	Teparies.	Cotton.	Maize.	Soya Beans.	Sunflowers.	Significant Difference	
						P = .05	P = .01
18.6	17.2	16.1	15.9	14.6	13.5	1.6	2.3

It will be seen that after sunflowers the soil was significantly drier ($P < .01$) than after any other crop except soya beans, and that except for tepary beans all the crops left the soil significantly drier than fallow ($P < .01$). The treatment means for the different depths are shown in Table XXII.

TABLE XXII.
SOIL MOISTURE CONTENT % AT END OF SEASON.

Treatment.	Depth.					Significant Difference	
	1'	2'	3'	4'	5'	P = .05	P = .01
Fallow	...	...	...	...	...		
Teparies	...	...	...	...	...		
Cotton	...	...	...	...	...		
Maize...	...	...	...	...	...		
Soya Beans	...	...	...	...	...	1.1	1.4
Sunflowers	...	...	...	...	...		

Some outstanding results indicated in the above Table are as follows :—

At every depth the fallowed soil had a significantly higher moisture content than any other treatment, *i.e.*, all the crops had removed some moisture at all depths down to five feet. (A possible exception to this is provided by the tepary beans at five feet, the difference from fallow at that depth just failing to reach to conventional five per cent. level of significance.)

At all depths below one foot the tepary beans had removed significantly less moisture from the soil than any other crop.

At all depths below one foot, the sunflower plots were significantly drier than any others, showing what an extremely desiccating effect this deep-rooting crop has on the soil.

The effect of the soya beans in drying out the soil was rather less drastic than that of the sunflowers, but was still considerable right down to five feet.

The cotton and maize were intermediate between teparies and soya beans in their desiccating effects at the lower levels.

In connection with the above results it should be noted that the cotton was very late planted (in December after the hail) and made extremely poor growth. Had this not been so it would doubtless have had a much greater drying effect on the soil. It is interesting to note that, small as it was, the cotton removed a significantly greater amount of moisture at one foot than the maize.

2. *Soil Nitrate Content 0-9 inches Depth.*—On 20.6.33, after the removal of all the rotation crops, samples for nitrate determination were taken from all plots of four blocks. Each plot sample was a composite of five samples taken from the surface to nine inches depth, and nitric nitrogen was determined on it as described above for the cotton after fallow and crop experiment 1931-32. The results showed a highly significant effect of treatment ($P < .01$). The treatment means are shown in Table XXIII.

TABLE XXIII.
SOIL NITRATES AT END OF SEASON. P.P.M. OF NITRIC N. 0-9" DEPTH.

Fallow.	Cotton.	Teparies.	Maize.	Soya Beans.	Sunflowers.	Significant Difference	
						P = .05	P = .01
9.02	5.70	5.13	3.32	3.32	2.91	1.07	1.49

It will be seen that soya beans, maize and sunflowers, while not differing among themselves, had all left the soil significantly lower in nitrate than any of the other three treatments. Also that the cotton and teparies had similarly left the soil significantly lower

in nitrates than the fallow. Attention must again be called to the fact that the cotton had made very poor growth.

When due allowance is made for the facts that the samples included the surface layer and that they were taken in the dry season, the results as a whole indicate a plentiful supply of nitrates in the loam at Barberton. The lower nitrate contents of the soya bean and maize plots, as compared with fallow, supply additional confirmation for the results found in previous seasons on cotton following those treatments. *Effects of Previous Soil Treatment.*

V. Cultivation Experiment. Effects of Soil Compactness.

In season 1932-33 a cultivation experiment was carried out, in which three different cultivation treatments designed to give different degrees of soil compactness were compared in four randomised blocks. The whole field was ploughed in June, 1932, with fair moisture. One treatment resembled the usual practice at this Station when moisture conditions etc., are good, *i.e.*, peg-tooth harrowing each way after Spring rains, and a further peg-tooth harrowing one way just before planting. This treatment left the soil moderately compact but not excessively so. A second treatment consisted of a single harrowing with a peg-tooth harrow crossed by a deep cultivation (to 9" depth) with a large rigid tyne cultivator of the semi-grubber type (Ransomes). This treatment had a further shallow cultivation with a spring tyne cultivator just before planting. The soil was then extremely loose and soft right down to ploughing depth. The plots of the third treatment had a peg-tooth harrowing one way, crossed, when the soil was not too moist, by a tandem disc harrow (set straight), a peg-tooth harrow and a pulverizer used as a roller. A further peg-tooth harrowing was given just before planting. This treatment left the land in a very compact condition.

The whole experiment was planted with U.4 2 (920 S.B.) cotton on 8.11.32. The damage caused by the hail in December was comparatively small on this experiment, and plant sampling for fresh and dry weights, etc., as well as height measurements were carried out through the season. The effects of the treatments on penetration of soil moisture, soil nitrate content and soil compactness were also investigated.

The treatment effects in an experiment of this nature are bound to depend to a great extent on the type of season. Interesting results have been obtained for 1932-33, but it would be premature to discuss them until the experiment has been repeated in several seasons. Yield figures may be given, however, as an indication that the effect of soil compactness may be of importance. Four pickings were made at fortnightly intervals and the yields were tested for significance by analysis of variance (Method 2) with the inclusion of the separate

occasions. No significant *average* effect of treatment was found, *i.e.* the totals of all four pickings did not differ significantly between treatments. The treatment *v* occasion interaction was, however, very significant ($P < .01$). The treatment means for each occasion are shown in Table XXIV.

TABLE XXIV.
YIELDS IN LBS. PER ACRE OF SEED COTTON.

Treatment.	Picking.				Significant Difference		Total Yield.
	1st.	2nd.	3rd.	4th.	$P = .05$	$P = .01$	
Compressed ...	284	210	227	101	57	78	822
Normal ...	332	227	193	68			820
Grubbed ...	179	192	242	119			732

It will be seen that the compressed and normal treatments both gave a significantly higher yield than the grubbed treatment at the first picking. Thereafter no significant differences occurred. This difference in earliness might be important if it occurred in a year of heavy stainer infestation.

ROTATION CROPS

BY

W. L. FIELDING AND M. F. ROSE.

GENERAL.

The question of suitable crops for rotation with cotton has been under consideration practically since the Barberton Station was started. The work was at first observational, but since 1929 more definite investigations have been in progress.

The theory underlying the conventional principle, "Rotation of Crops," applies to cotton-growing as to other types of arable farming, and needs no discussion here. Insect pest factors have given a specific importance to the rotation problem where cotton is concerned. An instance is the Chrysomelid beetle (*Syagrus rugifrons*), which attacks the stems and leaves of cotton seedlings, a one-year rotation being an effective control. The attraction of maize for bollworm is demonstrated in the section of this report dealing with insect pest control. Bollworm attack does relatively little damage to the maize crop and there is likely to be some incentive to cotton growers to plant maize from the trap crop point of view.

Cotton is usually planted on the first good planting rains. Planting of other crops will be done after the main cotton planting, and a rotation crop must therefore be capable of giving a yield when planted fairly late, say in mid-December. Again, it is important that as much

land as possible be autumn ploughed. Hence crops should have a maturation period allowing of their being taken off the land in time to carry out this operation.

Suitable short-period strains of various crops have been selected. Soya and tepary beans and groundnuts have proved the most promising legumes. Soya beans have grown well under adverse conditions, but their marketing presents difficulties. Tepary beans and groundnuts, on the other hand, are readily consumed in rations for cattle and native labour on the home farm, and are saleable in the interior. Tepary beans have an advantage over soya in that they can be taken off the land earlier, though against this is the fact that an early crop may ripen during the latter end of the rainy season, making harvesting difficult. Groundnuts are best planted fairly early, in order to avoid heavy "rosette" virus attack, this being a disadvantage in seasons where cotton planting is done on the late side. Maize is a useful crop in that it is very easily handled and its produce is readily consumed in native labour rations. It is probable that it will always be grown to some extent for these reasons. In comparison with sunflowers, maize can be taken from the land rather earlier, and it has been found that land is more readily autumn ploughed after maize than after the sunflower crop, which leaves it in a harder condition. Where it is decided to green manure land, sunnhemp has proved a useful crop.

Definite rotation experiments have now been laid down, in which cotton will follow cotton, soya beans, tepary beans, maize, sunflowers and fallow respectively, over a period of years. In time, therefore, considerable information should be available on the rotation question as a whole. The preliminary work on the selection of strains, spacing, etc., having been done, it will remain for the permanent rotation experiments to demonstrate the relative values of the respective crops in a rotation.

From the experience gained over the last few years it is now possible to give certain conclusions regarding the culture of several crops. These conclusions are reported, together with the present position regarding questions still undecided.

Various marketing possibilities for produce are noted under the respective sections dealing with each crop. The suitability of the various strains to markets and for various uses has been carefully ascertained, but under existing disturbed economic conditions it would be pointless to give current quotations which have been obtained for produce.

SOYA BEAN (*Glycine max*).

Varieties.—Observations have been made on a large number of soya bean varieties obtained from different countries. Some of these have grown well and given good yields of seed, but very few combined good yields with reasonable freedom from shattering. The *Yellow 1* type mentioned in previous reports has held its own as the best yielder and non-shatterer tested since work on this crop was commenced. This strain is indistinguishable from the variety known as *Southern* both as regards seed and plant. It has a maturation period of about four months and will retain its grain for from ten to fourteen days after the crop is ripe before serious shattering commences.

Bulk Crop of Yellow 1.—A fifteen-acre bulk of Y.1 soya bean yielded an average of 790 lbs. per acre. Planting occupied three days and by the time it was finished surface moisture was poor, giving the earliest planted part an advantage in getting away. A quarter-acre plot from the first day's planting yielded at the very satisfactory rate of 1,414 lbs. per acre. The crop was planted with a two-row planter, dropping seed every four inches in rows 2 feet 8 inches apart. It is interesting that the soya bean showed real ability to produce a reasonable crop under the very adverse conditions of the season, for, apart from undergoing severe drought, the crop was prematurely defoliated by caterpillars.

Spacing Trial.—Observation plots were planted in 1930–31 to see if there was any advantage in planting soya beans more closely than in rows 2 feet 8 inches apart, this being the closest convenient distance at which to sow with a two-row planter and also for inter-row cultivation. With plants 6 inches apart in the row, plots with rows 12 inches apart gave higher yields than those with rows 2 feet 8 inches apart. Following on this, properly designed experiments have been run during the past two seasons to investigate the possibilities of various inter-row and inter-plant spacings. The Barberton *Yellow 1* strain has been used throughout, and data from these experiments are tabulated below.

SOYA BEAN SPACING EXPERIMENT 1931–32.

Spacing.		Soil area available per plant sq. ins.	Yield per plant gms.	Yield per acre lbs.	Weight of 100 seeds gms.
Between rows ins.	Between plants ins.				
12	6	72	6.04	1159	14.7
32	4	128	11.16	1196	16.8
22	6	132	10.89	1140	16.9
12	12	144	10.63	1020	16.4
32	8	256	12.63	682	18.2
22	12	264	13.24	693	18.2
Difference for P=0.5			1.6	75	

NOTE.—The experiment was a six replication random block.

SOYA BEAN SPACING EXPERIMENTS 1932-33.

Spacing.		Soil area available per plant sq. ins.	Loam Soil.		Granite Soil.	
Between rows ins.	Between plants ins.		Yield per acre lbs.	Weight of 100 seeds gms.	Yield per acre lbs.	Weight of 100 seeds gms.
36	4	144	1041	20.2	1094	23.1
36	6	216	991	20.7	1186	23.6
24	6	144	922	19.2	1116	21.5
12	12	144	996	19.5	1141	20.9
24	12	288	1058	20.3	1084	22.2
12	6	72	845	19.8	1030	19.5

NOTES.—1. Both experiments were six replication random blocks. Ample provision was made against edge effect, three feet on either side being discarded as a guard area.
2. For yield per acre treatment effect was insignificant in each case.

The main conclusion from these experiments is that the absolute optimum spacing will vary with the nature of the season and even with the particular part of the season in which the crop is growing. Under one set of conditions a narrow spacing may be best, under other conditions, a wider spacing. It can, however, be said that the spacing of 2 feet 8 inches to 3 feet between the rows, and from 4 inches to 5 inches between plants in the row will usually be somewhere near the optimum, with the *Yellow 1* strain, giving every chance of a high yield under good conditions and a margin of safety should a period of drought occur whilst the crop is on the land.

The figures giving mean weights of 100 seeds for different spacings show that wider spacings produce definitely larger beans than narrower spacings. Where the crop is to be sold for oil extraction or for crushing for cattle food, or for other industrial purposes, the size of the beans is not of very great importance. Where the beans are to be used as seed, however, there is an advantage in having good, well-filled grain. Under South African planting conditions speed of germination is a very important factor. The following figures are from a laboratory germination test carried out with seed of the *Yellow 1* strain and illustrate the slow germination of small compared with large seed.

SOYA BEAN. EFFECT OF SEED SIZE ON GERMINATION.

Days from start of the test.	Percentage of Sample Germinated.	
	Small seed—100 seeds weighed 14 gms.	Large seed—100 seeds weighed 22.75 gms.
4	61.5	97.5
7	77.0	99.0
9	84.5	99.0
12	87.0	99.0
14	91.5	99.0

This experiment was run in a constant temperature and humidity room, the seed being placed between layers of filter paper on sterilized sand and having moisture throughout. In the field, after the average

planting rain, moisture falls to a very low level within a few days, unless more rain is received, so that many of the smaller seeds which germinated in the experiment would probably not have done so in the field.

Variation in size of plant at different spacings is illustrated by the yield per plant figures of the 1931-32 spacing experiment. A detailed analysis of the plants was made on this experiment and whilst it was found that size of plant increases gradually with increased soil area available, the morphological characters of the plant differ little.

Depth of Planting.—The depth at which soya beans are planted is an important factor in obtaining a good stand. On the heavy loam soil of the Barberton Station, if planted more deeply than two inches, the plumules may experience difficulty in breaking through the top layer of soil which may have become crusted by the time the cotyledons reach surface level. With a two-row planter it is possible to regulate depth of planting easily, but where single-row planters have been used plates have been fixed to the coulters to prevent their sinking too deeply on a puffy seed-bed.

Liming and Inoculation Experiment.—During the past three seasons trials have been run to investigate the influence of liming soya bean lands on the yield of beans and growth of root nodules. Difficulty has been experienced in inducing satisfactory production of nodules and the results, so far as the effect of lime is concerned, are contradictory. All the experiments have been in the form of randomized blocks.

In the 1930-31 season lime worked in prior to planting, at the rate of one ton to the acre, gave a significant increase in yield and in the growth of nodules. In this experiment satisfactory inoculation was obtained, plants on limed plots averaging eleven nodules per plant, those on unlimed plots having six nodules per plant.

In 1931-32 the experiment was affected by drought and white ant attack to such an extent that the results were valueless.

This season, 1932-33, Fisher's Z test showed treatment effect to be insignificant, but the plot means show a tendency for a depressing effect of lime on yield. The lime was ploughed in prior to planting, at the rate of two tons per acre. Inoculation was very unsatisfactory, the production of nodules being negligible. This experiment will be planted again next season.

Analysis of Yellow 1.—The figures given below show the analyses of samples of Yellow 1 soya beans grown under commercial conditions, in the one case on an estate, and in another on a farm in the Barberton area, compared with a sample grown in the same season, 1931-32, on the Experiment Station at Barberton.

ANALYSIS OF YELLOW 1 SOYA BEAN.

	Estate grown sample. %	Barberton area farm sample. %	Cotton Station sample. %
Moisture	7.8	7.8	8.7
Crude Proteins	40.0	39.2	36.5
Oil	17.9	17.0	18.3
Carbohydrates, etc. (by difference) ...	24.5	26.4	26.6
Crude Fibre	4.9	4.8	5.1
Ash	4.9	4.8	4.8
Nutrient Ratio	1 : 1.6	1 : 1.7	1 : 1.9
Food Units	169	167	164

TEPARY BEAN (*Phaseolus acutifolius*).

Experimental work with this crop has centred on the question of spacing, though some observational work has been done on time of planting.

Spacing.—Observation plots with wide and narrow spacings between the row, run in the season 1930–31 and 1931–32, indicated that tepary beans might benefit by a closer spacing than the 2 feet 8 inches between rows with plants 6 inches apart in the row, which was the way in which bulks were being grown. Randomized block experiments, actually replicas of the soya bean spacing trials, were run this season, both on the loam and on the granite soils. Results are inconclusive and will not be reported until more information is available.

Liming.—A randomized block experiment with lime ploughed in at a rate of two tons to the acre, against a no-lime experiment, was run this season. The results showed the same yield with lime as without, and there was no difference in seed weight. The plots of this trial will be again planted with tepary beans next season.

It has not yet been found possible to obtain a culture which will give inoculation of tepary bean roots.

The crop continues to be grown in bulk form for native ration purposes, and, with a general shortage of beans this season, has been readily saleable on certain markets within the Union.

MAIZE.

Varieties.—Examination of maize varieties has been carried on in some detail over the past four seasons. Nomenclature of maize varieties is uncertain, so that a lot of one variety obtained from one source may not always show similar characters to a crop grown from seed purported to be of the same variety, obtained from a different source. Small lots of seed of the common varieties in use in the Union have been obtained from different sources from time to time and grown in observation plots at Barberton. From the large number of strains thus tried a few have been selected as promising, and with this material

definite variety trial work has been done. Information regarding the length of the various growth phases and grain type of five promising strains is tabulated below.

MAIZE STRAINS.

Strain.	Planting to tasseling. Days.	Planting to silking. Days.	Planting to finish of flowering. Days.	Planting to ripe for harvesting. Days.	Type of Maize.	Weight of 100 grains. Gms
White Flint ...	60	63	71	125	Early maturing round white flint grain.	34
Peruvian Yellow	58	60	68	120	Early maturing round red yellow flint grain.	24
Arkell's Hickory	64	68	70	145	Late maturing large white flat grain.	54
Potchefstroom Pearl	65	69	72	145	Late maturing large white flat grain.	42
Anveld ...	61	65	72	125	Early maturing small white flat grain.	37

The flowering period and maturation period data cited above are from a collection of records taken over a three-year period, and show the approximate growth phase lengths which may be expected under Barberton conditions, given similar rainfall distribution to that which has been experienced over the last three seasons.

It has been mentioned in previous reports that with maize the aim has been to find firstly a white grained strain, of fairly early maturing type, capable of producing a fair crop, when planted rather late, say in December, after the main cotton acreage has been planted. Yield trials and observation show the White Flint cited above to be best suited to this purpose. In a trial run in 1931-32 with the best of the earlier maturing strains, White Flint gave a significantly higher yield than two dent type maizes of corresponding maturation period, Wisconsin and Anveld, the White Flint giving ten bags to the acre. This season, 1932-33, the four variety trials, early and late planted on both granite and loam soils, were adversely affected by certain factors, of which Witch Weed (*Striga lutea*) was one, so that actual yield figures were disappointingly low throughout. The trials were designed to give a direct comparison between the behaviour of short as compared with long maturation period strains, and from this point of view valuable confirmatory data were obtained. White Flint yielded well in comparison with the longer period Hickory and Potchefstroom Pearl.

The Peruvian maize mentioned in previous reports again showed ability to resist drought and Streak Disease, giving yields equal to White Flint in the earlier trials and beating it by a narrow margin in the later planted trials. In 1931-32 Peruvian gave an insignificantly lower yield than White Flint, with $9\frac{1}{2}$ bags to the acre. Apart from yield, the difference between these two flint types is in the use to which their grain can be put. Peruvian is only of real use for cattle or poultry food, the natives preferring meal from a white-grained maize such as White Flint.

Under the fairly good conditions which prevailed for the 1931-32 trial of longer period strains, a strain of Hickory King obtained from Mr. Arkell's farm in the Barberton valley gave a significantly higher yield than Potchefstroom Pearl, with 12 bags to the acre. It has proved quite the best long period maize tested. However, it compared badly with the shorter period White Flint in variety trials this season. Further, bulk crops of this Hickory on the Station were badly affected by drought in comparison with bulks of White Flint. Confirmation of this ability of White Flint to give some sort of crop in circumstances in which Hickory proves a failure through drought has come also from farms and from the Corporation's station at Magut, Natal.

Trials of long *v.* short period strains will be continued, as it is desirable to ascertain, if conditions permit, how they would compare if moisture were really good throughout growth. It is probable that the longer period Hickory would then beat the Flint, but if it did so by only a small margin, then Flint could be accepted as an all-round useful type. At the moment it can definitely be said that White Flint has been a superior yielder under the rather adverse conditions of the past few seasons when rainfall has been low and badly distributed. Peruvian has proved a useful type for late planting.

Resistance to Streak Virus Disease.—When observing maize variety plots in 1930-31 it was noticed that certain strains appeared to exhibit a degree of immunity to the "Streak" disease of maize, which frequently depresses maize yields in the Barberton area, particularly in later planted crops. The virus attacks certain indigenous grasses and it is probably always present in any area of veld. The disease is transmitted by a leaf-sucking insect, the maize jassid (*Cicadulina nibila*, Naude), there being no satisfactory control other than the possible finding of resistant strains of maize. It has been observed, however, that crops planted before the end of December, whilst exhibiting signs of attack in the form of chlorotic streak of the leaves, do not become stunted to as great a degree as crops planted at later dates. Crops planted from mid-January onwards are liable to complete failure by stunting through streak attack.

The streak factor being an important one, the observations mentioned above were followed up, and in the last two seasons definite counts have been made over the random blocks of the maize variety trials. Approximately 600 plants per variety were observed and classified, according to degree of streaking and stunting, as immune, or showing light, medium or heavy attack.

The data tabulated are from counts taken in the 1931-32 season. Data collected in the previous season and again this season confirm the figures closely, as far as the more important varieties are concerned, but two of the strains quoted were only observed in 1931-32.

RESISTANCE AND SUSCEPTIBILITY TO STREAK DISEASE IN MAIZE VARIETIES.

Strain of Maize.	Figures show percentage of stand having the type of attack denoted above each column.			
	Immune.	Light attack.	Medium attack.	Heavy attack.
Peruvian Yellow	91.5	4.5	3.5	0.5
Arkell's Hickory	65.3	8.5	14.25	12.0
Anveld	53.75	9.75	16.75	19.25
White Flint	50.5	17.25	21.25	11.0
Potchefstroom Pearl	45.8	10.0	16.50	27.75
Wisconsin	39.5	16.25	25.0	18.75
Natal White Horsetooth	36.8	7.50	21.25	35.0

The high resistance of Peruvian to the disease makes it a useful type for late planting. Arkell's Hickory appears to be the most resistant strain amongst the white grained maizes, but for late planting this quality is counterbalanced by a longer growing period than White Flint and Anveld. Although White Flint only shows a relatively low percentage of heavily attacked plants in the table, 50% of the stand has been affected, and the strain cannot be said to show any real degree of resistance. With the object of endeavouring to select a more resistant strain of White Flint, a large number of healthy plants in the bulk stands this season were tagged at silking, in places where the disease was bad in surrounding plants.

Of the other strains, Anveld shows a 50% immunity, but of the attacked plants, the percentage of those heavily attacked is high. Potchefstroom Pearl and Wisconsin are very susceptible varieties. Natal White Horsetooth is the longest period maize which has been tried on the Station, and is also the worst attacked by streak. An observation plot of Salisbury White, from Rhodesia, showed a similar susceptibility this season.

Apart from having brought out the definitely high resistance of Peruvian, the main value of the results is that they show that different strains do definitely exhibit varying degrees of immunity and susceptibility, and that therefore it may be possible to select a resistant strain from the variety which has high yield qualities.

Maize Fertilizer Trial.—In 1931-32 maize was planted over the previous season's cotton fertilizer trial plots. Four blocks of the old experiment were used, so that four replications were available. The variety of maize used was a dwarf flint type from Bechuanaland, maturing in the short period of 80-90 days, and giving only a very low yield. Yields per acre are therefore not of interest, and the mean plot yields are given, in pounds, in the table.

MAIZE FERTILIZER TRIAL—1931-32.

<i>Treatment.</i>	<i>Grain, mean plot yield lbs.</i>	<i>Dry weight at 41 days from planting. lbs. per 20 plants.</i>
KPN 	14.50	2.02
P 	13.88	1.73
PN 	13.50	1.77
KP 	12.25	1.69
KN 	7.00	0.71
N 	5.95	0.80
K 	5.19	0.86
Nil 	4.25	0.85
Difference required for significance at P=.05 	2.92	0.29

NOTES.—1. The fertilizer had been put down under the 1930-31 cotton, so that all manurial effects were residual.

2. All treatments including phosphorus as a component gave significantly higher yields and dry weight of young plants than treatments without phosphorus.

A cotton fertilizer trial on granite soil was wiped out by hail early in the season, 1932-33, and was replanted with White Flint maize. Owing to the effects of drought and Witch Weed attack, yields were useless, but samples for green and dry weight were taken and again confirmed the beneficial effects of phosphate. Phosphate plots gave an average dry weight of 5.79 gms. per plant compared with 4.75 gms. per plant on plots receiving no fertilizer treatment. Phosphate gave a degree of early maturity in the maize in all cases.

Witch Weed (Striga lutea).—Seed of this parasitic plant has spread over certain parts of the Barberton Station during the last two seasons, reducing yields in the bulk crops of maize grown for native ration purposes, and complicating the maize variety trial work. Witch Weed is also able to live parasitically on certain veld grasses and as one small cluster of plants may produce as many as a million seeds, control is difficult, the seed being minute and readily wind-carried.

A method of control adopted on one area was to plant the infected land with a very susceptible species of saccharine sorghum (Black Amber Cane), which resulted in quick germination of the Witch Weed seed, the whole being ploughed under when the parasite was in flower, thus killing it before its seed was set. Apart from green manuring value, however, this method means the loss of the use of the land for one season.

Another method was to send out a gang of natives once a week to pull up and destroy germinated Witch Weed plants which had

come into flower, thus again preventing the setting of seed. This method, whilst effective, is expensive; moreover, information is required regarding the length of interval that can be safely left between successive pullings.

Seed of *Striga lutea* having been observed to remain viable in the soil up to 20 years, rotation of crops is useless as a control.

GROUNDNUTS.

Over several seasons the strain of groundnut now called "Barberton," has proved the best yielder, against similar types such as Spanish 9 and Small Japanese. This strain was originally known as Gudiatham Bunch, being taken from a number of lots obtained from India, and has been renamed for the sake of simplicity.

This season it again did well in a trial on the granite soil of the Station, as against Virginia Bunch, the variety commonly used in districts of South Africa where groundnuts are grown on a large scale, such as the Springbok Flats of the Northern Transvaal. Spanish 9 and Natal Bunch, whilst superior to Virginia Bunch, were inferior in yield to Barberton.

GROUNDNUT VARIETY TRIAL—1932-33.

Strain.	Yields per acre of shelled nuts lbs.	Shelling out %	Statistical Note.
Barberton	1,251	71.98	The experiment was a four replication random block.
Spanish 9	1,011	72.34	
Natal Bunch	1,034	71.69	Difference required for sig- nificance at $P=0.05$ is 282 lbs.
Virginia Bunch	589	57.98	

Virginia Bunch suffered more during the drought of February than the other types. It has a more open structure and for this reason suffers more from the attack of the C.M.R. beetle, the insect having easier access to the flowers than in the other types.

For the first time for several seasons the "Rosette" virus disease was not a limiting factor, there being little sign of it on the Station till February, when a few infected plants were observed in a January-planted observation plot.

Seed of the Barberton strain of groundnut was supplied to the Spelonken Syndicate Estates and the following figures are an extract from their Una Farm Monthly Report for May, 1933. They are interesting evidence of the superiority of the Barberton strain over Virginia Bunch, both in yield and shelling percentage, when grown on a commercial scale.

GROUNDNUT EXPERIMENT: UNA FARM, LOUIS TRICHARDT.
SEASON 1932-33.

Variety.	Yield of undecorticated nuts from alternating eleven-acre sections of land. lbs.
Barberton	7,115
Virginia Bunch	5,122
Barberton	7,146
Virginia Bunch	5,896
Barberton	7,752
Virginia Bunch	5,623
Barberton	7,117

This gives an average yield of 662 lbs. per acre for the Barberton strain as against 504 lbs. per acre for Virginia Bunch. Further, the shelling percentage of Barberton is reported as 74 per cent. as against 67 per cent. for Virginia Bunch. Whilst a good deal of immaturity was reported in the Virginia Bunch, none was observed in the Barberton produce.

The above yields are low in comparison with yields from experimental plots on the Station at Barberton, but the crop was grown under poor moisture conditions.

Analysis and Marketability.—The Imperial Institute, London, reports that the Barberton and Spanish 9 strains gave satisfactory yields of oil. They would be readily saleable in the United Kingdom for oil crushing, preferably in the decorticated condition. They would rank with the East African Coramandel nuts on the market, but are not large enough for confectionery purposes in the unshelled state. The kernels, however, would be suitable for edible use, either for sale in packets or as an ingredient for cakes, sweetmeats, etc. The Barberton and Spanish 9 strains, with light coloured skins, resemble the Java kernels at present in demand. Oil obtained from all three samples would be suitable for use as salad oil or for margarine or soap making.

ANALYSIS OF BARBERTON STRAIN GROUNDNUTS.

<i>Composition of Nuts.</i>									
Kernel	...	...	...	...	...	...	...	...	79.7%
Shell	...	...	...	...	...	...	...	...	20.3%
Oil	...	...	...	...	...	...	...	...	38.6%
<i>Composition of Kernels.</i>									
Average weight of sound kernels	...	...	...	...	...	...	...	...	0.44 gms.
Moisture	...	...	...	...	...	...	...	...	5.4%
Oil in kernels as received	...	...	...	...	...	...	...	...	48.4%
Oil in moisture-free kernels	...	...	...	...	...	...	...	...	51.2%
<i>Extracted oil.</i>									
Acid value	...	...	...	...	...	...	...	...	0.1
Free fatty acids (expressed as oleic acid)	...	...	...	...	...	...	...	...	0.05%

NOTE.—The sample from which the analysis was made had been forwarded to London in the undecorticated state. The acidity of the extracted oil was satisfactorily low in each case.

Observational work on the incidence of "Rosette" disease in plantings of groundnuts on different dates will be continued. No

further work will be done with varieties unless it is desired to test a strain which has behaved outstandingly well elsewhere against the Barberton type.

SUNFLOWERS.

Varieties.—Many varieties of sunflower, black, white and striped, have been grown under observation in the past few years and the bulk of them discarded. Three of the most promising, St.3, B.4 and B.6 were put into a variety trial along with RW/6, a newer introduction from Rhodesia. The latter was included as it had given a good head in a short period and the head became concave on ripening, thus helping it to resist shattering. The results of the trial are shown in the table that follows.

SUNFLOWER VARIETY TRIAL, 1932-33.

<i>Strain.</i>	<i>Yield per acre—lbs.</i>	<i>Weight of 100 seeds gms.</i>	<i>Maturation Period. days.</i>	<i>Grain Type.</i>
B.4	1,474	9.35	140-150	Large Black
B.6	1,163	8.3	145-155	Small Black
St.3	1,348	8.0	120-130	Large Grey Striped
RW/6	634	6.8	Approx. 110	Small White

- NOTES.—1. The experiment was a four replication random block.
 2. Difference required for significance at $P=0.5$ is 355 lbs.
 3. The maturation period figures represent approximations computed from three years' observation in the case of B.4, B.6 and St.3. RW/6 has been more recently introduced and the figure given is a rough estimate.

St.3, originally a Russian type, was actually introduced in a lot from the Agricultural College at Guelph, Ontario. It is probably the most useful all-round type of which seed is available, producing a crop practically equal to the best of the black-seeded strains, B.4, but has about a three weeks shorter maturation period. As long as yield is maintained, and the type of seed produced is suited to market requirements, the greatest attribute a sunflower strain can possess is a short maturation period, so that the lands can be cleared in time to do autumn or early winter ploughing.

Introduction of Sunflower Material.—A collection of fifteen strains of sunflower seed, taken from experimental plots in various regions of Russia, was obtained from the Leningrad Bureau of Agricultural Science, via the Imperial Bureau of Plant Genetics, Cambridge. These were planted out in observation rows at Barberton this season and provided an interesting collection. Selections were taken in lots which grew well and appeared to be of really early maturing habit. Nothing definite can be said about them, as "place effect," where sunflowers are concerned, has always been observed at Barberton, and it takes two or three seasons before a strain settles to a normal habit in its new locality.

Selection.—Bulks of early and late-ripening heads were made in certain strains in 1931–32 and planted out this season in strips alternating with strips of maize in order to help to some degree in minimising cross pollination. The late lots proved true to type in that they were late, but otherwise they proved mixed. The early lots grew well and proved definitely earlier types. Definitely early lots were selected in the plots of B.4 and St.3 grown from 1931–32 early selected heads. It may be possible to select an early maturing, even ripening strain of these lots in this way.

Bagging of Sunflower Heads.—A very high percentage of cross fertilization takes place in sunflowers through the activity of insects. For this reason, although a certain amount of selection has been done, the strains in use on the Station are genetically very impure. Interesting work on the application of inbreeding to sunflowers has been done in Russia, and is referred to in a paper by E. M. Platschek in the *Journal Exp. Landw. S.O. Eur. Russ.* 1927:4. Sunflowers when inbred frequently prove sterile, but the Russian workers have demonstrated the separation of a percentage of weakly fertile and fertile groups.

A number of heads bagged at Barberton last season gave a percentage of fertile seeds which were planted this season. A small number of fertile seeds were again produced, but the process seemed to have had the effect of greatly increasing the maturation period of the strains. Inbreeding with sunflowers seems to have possibilities, but the economic value of sunflowers as a rotation crop for cotton will probably not justify such intensive work.

Sunflower Spacing Trials.—The influence of various spacings between plants in the row, on the yield of sunflowers, has been examined over a period of years. Apart from taking final seed yield figures, a study has been made of the influence of spacing on the proportion of the head which bears fertile seed. A certain area in the centre of a sunflower head appears always to produce unfilled seed, and an average figure for this was obtained for each spacing, together with a ratio of the infertile area to the total area of heads obtained.

Data from two experiments are given and illustrate the general range of differences which have shown up in trials over a period of years.

SUNFLOWER SPACING TRIAL, B.6 STRAIN, 1931–32.

<i>Spacing between plants. Inches.</i>	<i>Ratio of infertile area of head to total area of head. Percentage.</i>	<i>Yield per 1/40 acre (Mean plot Yield), Lbs.</i>
18	8.02	17.31
24	5.10	18.56
30	1.42	21.94
36	0.97	19.52
Difference required for significance at P=.05 	2.08	2.89 lbs.

SUNFLOWER SPACING TRIAL, ST.3 STRAIN, 1932-33.

Spacing between plants. Inches.	Ratio of infertile area of head to total area of head. Percentage.	Yield per 1/40 acre (Mean Plot Yield). Lbs.	Weight of 100 seeds. Gms.
18	2.4	35.48	7.75
24	1.6	34.11	8.12
30	0.83	30.13	8.47
36	0.78	30.40	9.02
Difference required for significance at P = .05	—	2.34	0.58

The decrease in the ratio of the infertile area of the head to the total area, with increase in inter-plant spacing, is noteworthy.

Summing up the spacing question, it seems probable that with rows 3 feet apart, a spacing of 30 inches between plants is about right for the black strains such as B.6 and B.4, and 18 inches to 24 inches between plants for the shorter growth period of St.3.

Analysis of Sunflower Seed and Heads.—Samples of seed from the St.3 and B.4 strain of sunflower have been analysed by the Imperial Institute. Also samples of meal made in one case by crushing whole heads (unthreshed) of a black-seeded strain similar to B.6, and in the other by crushing the threshed-out heads from a black strain. The two latter analyses are of interest to the cattle or dairy farmer who may grow sunflowers in order to have the produce crushed for use in the concentrate ration for stock.

ANALYSIS OF SUNFLOWER SEED AND HEADS.

	B.4 seed.	St.3 seed.	Threshed heads (minus seed).	Unthreshed heads (with seed).
	%	%	%	%
Moisture	6.7	6.3	20.2	10.0
Crude Proteins	14.0	18.4	7.3	11.6
Oil	24.6	26.0	2.6	12.7
Carbohydrates etc. (by difference)	20.9	18.7	48.7	34.5
Crude Fibre	31.9	28.0	13.5	22.9
Ash	1.9	2.6	7.7	8.3
Nutrient Ratio	1 : 5.5	1 : 3.3	1 : 7.5	1 : 5.5
Food Units	117	130	73	95

From the Table it will be seen that the St.3 has an advantage over B.4 both in oil and protein percentages. The sample on which the analysis of meal from unthreshed sunflower heads was made was taken from meal actually in use for feeding dairy cattle in the Barberton district and is therefore of practical interest.

Markets.—From remarks made by the Imperial Institute, it seems that the sale of sunflower seed on United Kingdom markets would not be economic, owing to the fact that it is less used for oil crushing than formerly, and also to the fact that certain European countries which grow the crop now crush seed themselves and export the oil. The quantity consumed for bird seed is very small, only from 100 to 200 tons annually.

Regarding other markets, a quantity is shipped annually from Cape Town to Australia, striped seed, such as St.3, being required for this purpose. Sunflower seed is saleable on the Johannesburg market, this produce being mostly used in the preparation of mixed poultry food.

LIMA BEAN (*Phaseolus lunatus*).

Mention has been made of this bean from time to time, in the Reports. Apart from observations and the taking of yields from observation plots no definite work has been done on the question of its spacing etc., because it seemed uncertain whether the crop would grow satisfactorily under Barberton conditions. It has been kept under observation, however, because of the high market value of the beans, in comparison with the value of other beans on United Kingdom markets.

The strain with which all observational work has been done was obtained from Nyasaland, but came originally from the United States. Plants have shown increasing growth vigour from year to year, the crop looking a far more healthy one during the last two seasons than when grown during the first two years after the seed was obtained.

In Madagascar, where the crop is an important one, the beans are planted towards the end of the rains. The reason for this is that *P. lunatus* is prone to shed its pods in the green state when grown under conditions of excessive moisture. In Burma, where this crop is also grown extensively, this phenomenon is reported not to have been observed.

In early planted lots at Barberton, in 1929-30, a wet season, a degree of pod-shedding was observed, and it was thought that if the crop were grown at all it would have to be late planted for this reason. During more recent seasons which have been of low rainfall, there has been no serious loss of yield in early planted lots through this cause, but on the other hand, later planted lots have suffered from another factor, attack of the large Cantharides beetle, known as the "C.M.R.", which destroys the flowers of the crop.

From this point of view data from the observation plots planted on different dates are of interest. A plot planted on December 19th, 1930, gave a mean yield per acre of 585 lbs., whilst a plot planted on December 21st, 1932, gave a yield of 807 lbs. per acre. Plots planted in early and late January have shown decreasing yields, 168 lbs. for a planting on January 6th, 1931, and 37 lbs. per acre for a planting on January 24th, 1933. A two-acre bulk planted on February 8th, 1932, yielded at the rate of 343 lbs. per acre, but a plot planted on March 2nd, 1933, was a complete failure. The late planted plots grew well and

appeared to like the late conditions, Lima beans showing a high degree of drought resistance, but in each case attack by C.M.R. beetle was the limiting factor to yield.

Observations record the appearance of the beetle usually about mid-February, the attack becoming really bad in March. *P. lunatus* appears to be in full flower at from 45–55 days from planting, and if planted in mid-to-late December should avoid the more serious influx of the beetle in March. If future seasons show that pod-shedding is likely to be serious with such plantings, however, this crop will not be safe enough to be of much real value.

Introductions.—Five types of *P. lunatus* were obtained from the Economic Botanist, Burma, who has carried out breeding work on the crop. Grown in observation plots this season they did not appear to grow well under Barberton conditions but if grown next season from the Barberton-grown seed may show up differently.

MISCELLANEOUS NOTES.

Sunnhemp (Crotalaria juncea).—Where it is desired to plough in a green manure, sunnhemp is usually used for the purpose. In the Barberton district the crop gives a good yield when grown for seed. Market requirements for seed are spasmodic, but sudden demands occur, and in such circumstances the crop can prove a very remunerative one. From this point of view it is useful that the seed should store well, so that produce can be held over till market conditions are good.

Sugar Beans (Phaseolus spp.).—This crop was again grown under observation this season, but appears to be of little likely use as a rain-grown crop. However, farmers in the area grow sugar beans and allied *Phaseolus* types, such as Canadian Wonder bean, under irrigation during winter, for green beans.

Mung Beans (Phaseolus aureus and P. mungo).—Five lots of Mung bean, obtained from Trinidad, were grown in observation plots this season. All grew poorly, proving very susceptible to aphid and jassid attack. In this they were similar to Danubian beans, another *Phaseolus* species grown in 1931, and are not likely to be of any use in the area.

Pigeon Pea.—A series of early maturing strains of Pigeon Pea (Pusa rahar type) were obtained from Pusa, India, and grown this season in small plots. The strains display a range of plant types, from bushy to tall, and all have set some seed. The crop is not likely to be of use for seed, but the material obtained may prove useful in connection with the question of windbreaks.

Other Phaseolus Species.—Canadian Wonder bean, and Kidney and Painted Lady beans proved useless under summer conditions this season.

INSECT PEST CONTROL.

Investigations by members of the Corporation's staff on the control of cotton insect pests commenced at Barberton in 1929-30. Since then the trend and progress of this branch of the work at the Cotton Station have been stated in the form of summaries only in the annual volume of Reports from the Corporation's Experiment Stations. A full report on the work of the past three years has been prepared and it is hoped that this will be issued in the form of a separate publication. The present summaries have been composed from information given in the full report.

INVESTIGATIONS ON THE AMERICAN AND THE RED BOLLWORMS OF COTTON.

BY

F. S. PARSONS AND G. C. ULLYETT.

From the beginning of the work on bollworms at Barberton much attention has been given to a study of indigenous parasites, particularly of the egg parasite, *Trichogramma lutea*. This and other parasites have been bred in large numbers and tested extensively for their value in crops. Concurrently with this work it has been necessary to ascertain the course of bollworm infestations and the extent of parasitism occurring naturally in varying egg and larval populations throughout the seasons of the year. This information was essential, if only for purposes of comparison, on the occasions when parasites were released for trial. In this connection, however, many important factors required consideration, such as the duration of egg-laying by bollworm moths on different crops; the particular condition of plant growth, if any, associated with oviposition; the relative attractiveness of hosts, and other matters which may be termed bollworm-host plant relationships. All these relationships required to be studied and in order to obtain adequate information on them it was necessary to introduce a system of continuous observations and recording. Although this work was organised primarily to provide information considered necessary to the conduct of parasite investigations, all the data that have been accumulated are really essential to field investigations on bollworm control as they served to state the problems.

Since the inception of systematized and quantitative recording in the field, information has been obtained on bollworm-host plant relationships which indicates feasible methods of crop management whereby American bollworm may be diverted from cotton. The early information on this subject was important and warranted considerable expansion of this branch of the studies on bollworm, and an additional result has been the inauguration of co-ordinated investigations and methods of recording between members of the Corporation's staff in the Union, Swaziland and the Rhodesias.

I. *Methods of Field and Laboratory Survey—Bollworm.*

Methods have been devised which provide for the accumulation on standing crops of continuous quantitative data under the following general heads.

1. The course of oviposition in point of duration and time of occurrence in the life of a host crop. The observed course of these events serves well to indicate moth activity and the relative attractiveness of hosts.

2. The identity and activity of egg and larval parasites under natural conditions.

3. The identity and activity of insects predatory on the eggs and larvæ, as occurring in the varied insect communities associated with different crops.

4. Comparative mortality of larvæ in the different host crops where oviposition has been recorded.

5. Observations on growth and fruiting of host plants in relation to both egg and larval populations.

It has been found that eggs laid by the moths of both bollworms are most unevenly distributed over a crop in correlation with certain conditions of vegetative and reproductive growth. In view of this, records must be taken in all sections of the crops under survey. The method is to mark off each field into numerous blocks of convenient size and take a number of sample plants in each, upon which to record and collect eggs and larval material.

Eggs are counted twice weekly. In routine work a sample of these is collected twice weekly for incubation and observations on the presence and identity of parasites; the remainder are brushed off. If experimental releases of an egg parasite are in progress in a crop, however, eggs are marked *in situ* in order to obtain data on the fate of egg populations as they occur on the plant. Satisfactory methods of marking eggs and differentiating between oviposition periods have been devised and applied.

Larval populations are recorded at weekly intervals and samples drawn from them for observations on parasitism, growth development and pupation behaviour, under methods of treatment which simulate natural conditions closely.

All the survey work has been placed upon a routine basis. Continuous and intensive recording of the kind undertaken requires the services of a relatively large staff of observers. In our case these are supplied by natives trained to do the work under European supervision. It may be accepted that trustworthy results are supplied by the class of observer obtainable, when supervised properly, and natives undoubtedly withstand the prolonged tedium of such work infinitely better than do Europeans.

It has been possible by adhering to a calendar of operations, to record bollworm material, as indicated, over the Cotton Station and seven farms in the district throughout the past year.

At the present time at Barberton, the authors, five European assistants and seven natives are engaged on bollworm survey work. Three of the European assistants are receiving training before being posted to do similar work in Swaziland and Natal.

Some of the results from these preliminary surveys are referred to later.

II. *The Course of American Bollworm Activity on Rain-Grown Cotton, Maize and Other Crops.*

Cotton and maize were the principal crops in growth, but the survey included numbers of others which are hosts of the bollworm.

Oviposition was found to be very closely associated with the period of bud and flower production. The duration of egg-laying thus varied according to the flowering habit of host plants.

In the case of maize, oviposition in quantity commences when the tassels (staminate flowers) are extruding and the peak of oviposition is past before silks (pistilate flowers) are abundant. This information has been obtained from intensive observations on some 20 maize crops of widely differing variety, planting dates and growth conditions.

Oviposition on maize here lasts for two to three weeks only. This is at variance with the widely accepted view that the plant is oviposited on during much of its life and most heavily during the silking period.

Numerous instances came under observation where maize in tassel was laid upon by the American bollworm moth to the practical exclusion of neighbouring cotton in freely fruiting and healthy condition. On several farms, including the Cotton Station, three and more commercial crops of maize came into tassel in timely succession and each of these was oviposited on in varying degree during the period of tassellation,

whereas no eggs or, at the most, very few were to be found on the cotton while maize in tassel existed. On other farms, where only one or two plantings of maize had been made, it was observed that the oviposition on cotton ceased when neighbouring maize plants came into tassel and eggs did not occur, except rarely, on cotton again until the oviposition of maize fell off. Several very striking examples of this course of events came under our observation.

The attraction to the American bollworm moth of maize in tassel was demonstrated clearly in both routine and experimental work and possibilities of exploiting this relationship and diverting the activities of American bollworm from cotton are being investigated. Sunflower, groundnut and bean crops may also be of considerable value in this connection.

Although the use of maize for trap crop purposes in cotton-growing countries has been advised from time to time, the practice has also been discountenanced (Entomological Conference of the Transcaucasian Cotton Committee, 1929), because it was held that the moths bred in maize would increase later infestations in cotton. Our evidence from larval surveys in both crops is that the percentage survival of American bollworm is greater in cotton than in maize. As will be mentioned in the section on the presence of American bollworm during the cool season on irrigated crops, the evidence is that moths bred there enter rain-grown crops present later on the same and contiguous farms. Where no maize was in growth last year they oviposited on cotton as the records show. In these cases, according to the evidence of our larval surveys, more moths would be bred in cotton lands per equal population of eggs than resulted in the instances when maize was present in tassel and received the attention of moths. If a timely succession of maize and possibly other rotation crops exists on the same farm, and eggs are laid on them rather than on cotton there would, on the basis of comparative larval survival, be a general reduction of bollworm. An argument against the above may be that the moths are stimulated by maize to lay more of their eggs thereon than they would be stimulated to lay on cotton in the absence of maize. At death there are still numbers of developed and undeveloped eggs in the ovarioles and oviduct which might be laid under special stimuli. Such stimuli may arise during that part of the life of the maize plant which is associated with oviposition. We have no information as yet on this point.

III. *The Course of American Bollworm Activity on Winter-Irrigated Crops and Citrus Orchards.*

The methods of survey referred to have been applied to a study of the bollworm in these crops, of which there are relatively large acreages.

The evidence from the past season's intensive work is that the bollworm breeds extensively in vegetable crops, particularly a month or two prior to rain-grown cotton and maize. The percentage survival of larvæ is very high owing to the practical absence of insect agencies which impose checks on the larval population; and a large emergence of moths takes place in these lands when rain-grown crops are again in evidence to furnish a continuation of host plants.

In the present year oviposition on the citrus observed ended by October 7th, the latest egg-laying being on Valencia orange trees. Larvæ bred on these trees and pupating in October may be expected to give rise to moths late in November. It is possible that early summer crops would be laid on by these moths as well as vegetable crops still in growth. From information obtained in other years, however, it is known that the blossoming time of citrus varies considerably. In some years blossoming may not occur until late October. Moths derived from eggs laid on citrus then would be in flight at the end of December. Most of these moths would come from orchards of Valencia trees where the latest breeding of bollworm on citrus takes place. We are indebted to the officials at the Government Sub-Tropical Experiment Station, Nelspruit, Transvaal, for the information that there are approximately 800,000 citrus trees in this and neighbouring areas; of these approximately 400,000 are Valencias. It is conceivable that circumstances may arise which cause citrus trees to blossom unusually late in a season favouring the early development of rain-grown crops. The late emergence of moths from such extensive breeding grounds could then occasion an "epidemic" infestation of American bollworm on cotton, such as we have experienced in the De Kaap Valley on former occasions. Future survey work should afford exact information on this point.

IV. *Larval Parasites of the American Bollworm.*

It has been determined from a study of larval parasitism over three years that a Tachinid fly, *Sturmia inconspicua*, Mg., is the only indigenous parasite of importance. This fly does not, however, parasitise young larvæ. There is, in our experience, a relative scarcity of insects parasitic on the larval stage and an absence of any which parasitise the early growth stages of the worm. Attention should be given, therefore, to the advisability of importing parasites under authority from the Government of the Union.

Breeding and experimental releases of one larval parasite, *Microbracon brevicornis*, have been carried out. This parasite occurred in association with the bollworm on certain ornamental flowering plants

here, but has been recorded by one of us (Ullyett) in field crops of maize.

According to experimental evidence, which will be published later, it has been determined that larvæ parasitised by *M. brevicornis* in the field decompose very rapidly under the conditions of high humidity and temperatures obtaining at larval sites on the plant during the summer months. Decomposition is generally too rapid to permit development of the parasite larvæ and hence multiplication is minimised.

INVESTIGATIONS ON *Trichogramma lutea*, GIRAULT.

Trichogramma lutea is an indigenous parasite of the eggs of the American and red bollworms of cotton. When work on the control of cotton pests was undertaken by members of the Corporation's staff at Barberton it was decided to investigate the possibilities of exploiting this parasite.

Provision was made in 1930 to breed *T. lutea* in large numbers in eggs of the common grain moth, *Sitotroga cerealella*, according to technique devised by Flanders.* Mass production proceeded satisfactorily under the methods employed, although we encountered strains of the parasite which would not breed in the eggs of the grain moth. Sufficient numbers of *Trichogramma* were bred in the first year of the work wherewith to conduct preliminary experimental releases in crops of cotton. These early investigations served mainly to indicate the nature of the observations required in the field in order to assess the value of released *Trichogramma*.

It was realised early in the course of this work that the history of individual eggs occurring on plants required to be known, otherwise parasitism could not be estimated with a reasonable degree of accuracy. Some of the reasons leading to this decision are as follows:—Any sample of undated bollworm eggs collected from plants contains eggs ranging in age from those several days old and about to hatch, to those laid over night, with consequent differences in the length of time they were exposed to parasitism. A collection of eggs which are mainly 48–60 hours old may be parasitised to the extent of 70%, whereas a collection composed largely of eggs deposited over night may be parasitised to the extent of 5% only. Furthermore, the eggs are destroyed *in situ* in very considerable quantities by *Orius* sp. and other predators and agencies. It is of course the surviving egg population

* Flanders S.E. "Biological Control of the Codling Moth." J. Econ. Ent. XX. 644. "Mass Production of Egg Parasites of the Genus *Trichogramma*," Hilgardia, Vol. 4, No. 16. June 1930. Calif. Agr. Exp. Stn.

which contributes larvæ, and it is the parasitism of these surviving or effective eggs that it is important to know in evaluating the usefulness of an egg parasite.

Particulars of the manner in which eggs are marked *in situ* on host plants are omitted in the present discussion. These methods were evolved largely to meet the needs of studying the course of egg parasitism by *Trichogramma* in release experiments. They enable data to be obtained in the crop on the parasitism of the effective fraction of the egg population.

In this work the fields of crop utilised for release purposes were marked off into blocks of $\frac{1}{4}$ -acre and a sample of record plants was taken in each block, the sample being commonly sixteen plants per $\frac{1}{4}$ -acre. This procedure enables parasitism to be followed over areas of light to heavy oviposition, which, as previously stated, occur in practically every crop.

The larval population was estimated weekly in each block according to the method of head capsule width (Dyer's law, 1890), and the percentage survival of larvæ computed. The data for larval population in blocks where the parasitism of effective eggs differs, furnish information on the significance of percentage parasitism of eggs.

In our experiments, up to the present *T. lutea* has been released on the wing, following emergence and fertilization in breeding containers. Releases were made in the centre of small fields or from several points in the middle of large fields.

Release Experiments in Rain-Grown Cotton and Maize.—The intensive methods of recording referred to above were applied in the first instance to field investigations on *T. lutea* during the season 1931–32. The results of that season's work in this connection were indicated rather fully in the summary contained in the volume of reports, 1931–32. The chief observations made were :—(1) that *Trichogramma* released in the summer months appeared to disperse in both crops more widely and rapidly than anticipated and (2) that oviposition on maize was of much shorter duration than was expected (this was before the field survey methods had been applied to a study of bollworm-host plant relationships). Owing to the short period of oviposition on maize it was not possible to carry out fully the release experiments which had been planned.

Last year's summary contained preliminary details of a release experiment in maize which was put into execution at the end of the winter. This experiment was still in progress when that summary was prepared, containing a statement that an egg parasitism of 74% had been recorded up to the time of writing. The final percentage

parasitism in this experiment was 80%. This did not result, however, as forecast in the report, in a decided reduction in the numbers of larvæ compared with conditions obtaining in control areas of relatively low egg parasitism. On the contrary, analysis on proportionate grounds of the data for larval survival in the experimental and control areas showed that the percentage survival was practically identical in all cases.

In view of the dispersion behaviour observed in last year's experiments, larger areas of crop were chosen for releases in the season 1932-33. Provision was made also to release much larger numbers of parasites per unit area in an endeavour to bring about a *continuously* high parasitism. In former experiments parasitism, at the most, increased only gradually, if oviposition was sustained. It was generally the case, however, that a large proportion of the total eggs laid, often more than 50%, hatched before parasitism rose above 30%.

There were three main experiments in 1932-33. The principal results from these are discussed briefly below.

Experiment No. 1—Releases in Maize.—This experiment was conducted on a farm near Barberton in a fifteen-acre field of maize. The field was marked off into 60 blocks of an area of $\frac{1}{4}$ -acre each. Parasites were released in the middle of the field twice weekly at the rate of 9,000 per acre per week. This is double the number used previously.

Concurrently with the collection of data in this experiment, records were being taken on the course of natural parasitism in maize and other crops at various points in the neighbourhood. The highest figure for natural parasitism recorded anywhere in the district during the period (December to January) was 29%. This occurred in a field of maize some miles away; otherwise the figures ranged from 7% to 13%. No parasitised eggs were found on any other crops or other host plants on the farm prior to releases. None of the earliest eggs found on the crop recorded were parasitised before parasites were released. It was assumed from these observations that when the experiment commenced parasitism due to naturally bred *Trichogramma* was non-existent or negligible.

As parasitism was being recorded in all parts of the field at once, it was possible to determine when, and to what extent, it occurred in portions of the field well removed from the points of release. These records supplied information on dispersion behaviour.

In brief, it may be said that dispersion was very rapid and extensive, so much so, that the parasites travelled to the confines of the field in less than 24 hours after the first release was made. There can be little

doubt also that large numbers left the field altogether, as the parasitism of eggs on plants in the marginal area of a neighbouring field of maize rose from nil to 40% in the week following the initial two releases in the experimental area. There was abundant evidence that the dispersal of parasites released on subsequent dates was equally rapid and widespread.

The chief value, for our purposes, of releasing laboratory-bred *Trichogramma* in field crops would be to benefit from the massed activity of the parasite at desired points. As the strains of *T. lutea* used in our work up to the present disperse so rapidly, sustained mass action is definitely not obtained.

Apart from the above, it was thought at that time that oviposition on maize endured for a comparatively lengthy period, and consequently the natural increase of *Trichogramma* from eggs parasitised by released parasites, would add very materially to the parasite population. Experience in the previous year, however, had been otherwise and attention was being given to the course of egg-laying by American bollworm moths on various crops. In the present instance oviposition was in progress for only 18 days, and, of this time, was extensive for little more than a week. This, as has been found out since, is the typical course of oviposition on maize here. The developmental period of *Trichogramma* in the egg in the field is 7–9 days during the summer and hence in this case only one generation of the progeny of the released parasites could have emerged in time to increase the population while parasitizable eggs were still present in numbers.

Despite the foregoing the percentage parasitism of the eggs in many blocks of the field, not necessarily those where releases were made, ranged from 60–80%.

Percentages of survival of larvæ under the different conditions of egg parasitism in this experiment have been computed. The differences between these were of no consequence for practical purposes.

Experiment No. 2—Releases in Cotton.—The releases were made in the centre of a field of cotton of about 23 acres in extent. Parasites were released twice weekly at the rate of 9,000 parasites per acre per week. Releases were made over a period of a month. Records were taken in the central 4 acres only. Although a moderately heavy oviposition was in progress, parasitism of American bollworm eggs never exceeded 12% and of red bollworm eggs 2%.

Experiment No. 3.—Releases on the Cotton Station, Barberton.—*Trichogramma* was released weekly at the rate of 5,000 per acre per week in all crops where egg-laying by American bollworm moths was in progress. Parasitism of both American and red bollworm eggs in cotton

was negligible. In maize it attained 40% in one case, but was generally less than 30%.

Releases of T. lutea in Maize and Cotton at Gatooma, Southern Rhodesia.—These experiments were organised and carried out in co-operation with J. E. Peat and co-workers at Gatooma during the past season. They were essentially the same as the experiments at Barberton as discussed above. The parasites released at Gatooma were bred at Barberton for the purpose.

Low percentages of parasitism were recorded throughout the periods of observation.

In view of the results from the Experimental releases in rain-grown crops, as above, it has been decided to discontinue breeding and field trials of the strains of *Trichogramma* with which we have been working.

Recently a strain of *Trichogramma* was procured by the senior author when at Gatooma. According to records on natural parasitism in maize and cotton, which have been accumulated by Peat in Southern Rhodesia, this strain promises to be of considerably greater value than any that we have procured from wild stock in the Union.

The Rhodesian strain is being multiplied at Barberton and at the present time is being released experimentally in irrigated vegetable crops. It is proposed to utilise it later in the year for trials in fields of cotton.

The results of these investigations and various other data which have been obtained here in the course of work on *Trichogramma* will be published separately later.

INVESTIGATIONS ON THE RED BOLLWORM.

Exposure and Destruction of Pupae by means of Farm Implements.—Preliminary work on this subject was rather fully summarised in the Report for 1930–31. Since then attention has been given during one season (1932) to a study of the position in the soil of red bollworm pupae as they occur naturally in fields of growing cotton. Investigations covered different soil and growth conditions and afforded valuable information on the location of pupae within the portion of the inter-row area covered by cultivating implements.

Owing to the cessation of operations on the estate where the work was being carried out the data are incomplete and it has been necessary to postpone the investigations until arrangements can be made elsewhere where red bollworm is more plentiful than at Barberton.

The Utilization of Small Areas of Ratooned Cotton for Purposes of Attracting Red Bollworm Moths.—In order to provide the trap, cotton

plants must be ratooned or allowed to stand over after picking is completed. Whether ratooned or stand-over, fruit will, in all probability, be in evidence on the plants sometime in the winter months. Unless this is removed and destroyed at appropriate times, after oviposition commences in the winter months, larvae will proceed to pupation. According to recent records the pupal periods of these are frequently of sufficient duration to mean that moths may not emerge until January, after the trap has ceased to attract moths. Formerly it was thought that pupae formed from the early larvae on trap plants would all give rise to moths before plant cotton was in bud.

Recent records have shown that the percentage survival of red bollworm larvae in the dry season months is much higher than it is in the Summer, due no doubt to the comparative absence of insect agencies serving to reduce their numbers. It may be expected in consequence that a relatively large proportion will pupate. The accumulated pupae formed over August and September in a warm winter season might well give rise to as many months as, or even more than, would emerge in cotton lands from the over-wintering pupae themselves, as evidence points to a heavy mortality amongst the latter in the field.

Prior to the recent adoption of more frequent examinations, the view was held that the numbers of larvae bred in trap areas in mid-winter were negligibly few. This is found not to be the case and fruit must be collected off the trap plants and destroyed every 3 to 4 weeks after egg-laying commences. This involves constant observation to determine when egg-laying does begin. It is doubtful if the necessary measures would be taken in general practice by cotton farmers and the method of trapping as a means of red bollworm control is being discouraged.

The Variable Incidence of Red Bollworm.—Of late years the annual infestation has diminished greatly in some districts, but not in others. These variations are attributed mainly to (i) The presence or otherwise of ratooned cotton, particularly in a mild winter. Under favourable circumstances ratooned cotton offers every opportunity for the multiplication of red bollworm, and plant cotton in the neighbourhood may be heavily attacked towards the end of the season by bollworm bred in the ratoons. Instances of this have been recorded. The acreages under ratooned cotton are greatly diminished in some areas, less so in others, and the severity of attack by red bollworm appears to be related to the amount of ratooned cotton present. (ii) Seasons of very late planting have been experienced in recent years. According to records, moth emergences from over-wintering pupae are practically

complete by the end of December and in the absence of ratoons late planted cotton avoids the great majority of these moths, as events have indicated.

INVESTIGATIONS ON COTTON STAINERS AND INTERNAL BOLL DISEASE

BY

E. O. PEARSON.

Investigations on this problem have been in progress at Barberton since the season of 1931-32. During that and the following season Mr. Parsons carried out observations on the migration of stainers to the crop and the damage resulting from that migration, on some of the wild host plants of the stainer and on possible methods of trapping the stainer in the crop. Since November, 1931, it has been possible for the writer to carry on whole-time work upon the problem.

Investigations have primarily been directed to cotton stainers. Following the experience gained from different methods of estimating the stainer population on the Cotton Experiment Station in 1931 and 1932, a uniform system of recording populations by sampling 10-acre blocks was employed in 1933 on the Cotton Experiment Station and four farms in the Barberton district, and also, in collaboration with Mr. Lochrie and Mr. Bowmaker, on three farms in Swaziland and the Experiment Station at Magut, Natal. The records so obtained show that in the absence of adjacent ratoon or stand-over cotton, stainers appear in plant cotton at the end of February or the beginning of March, the migration reaching a peak about a month later. *Dysdercus nigrofasciatus* appears earlier than either *D. fasciatus* or *D. intermedius*. The last named species is present in small numbers only throughout the season. *D. nigrofasciatus* and *D. fasciatus* are very variable in relative abundance. In 1931 and 1932 *D. fasciatus* appeared in large numbers and bred up a very large population in the crop. *D. nigrofasciatus* appeared in about equal numbers, but the natural increase was very much smaller than in the former species. In 1933 *D. fasciatus* was practically absent from all points save those which were in the vicinity of adjacent ratoon or stand-over cotton.

The stainer population varied as a whole from farm to farm, according to the condition of the crop. Detailed studies of the distribution of stainers within a single 10-acre block and comparisons of the population on coarse strains of U/4, e.g., 9264 and 913, with that on finer varieties, e.g., 9312, indicated that population density varied with the amount of cover available rather than with the amount of crop matured.

Where the normal migration occurs, all three species of stainer pass through two and a partial third generation on the crop. At the end of the season, when the crop is cleaned up, some of the adults migrate from it and the remainder, together with the great majority of the nymphs, can be destroyed. Clean-up measures on the Cotton Experiment Station at Barberton, in which the cotton is cut out, stacked and these stacks shortly afterwards burnt, the land being ploughed as soon afterwards as possible, have been very successful. Trapping on seed heaps followed by destruction of the catch by periodical sprayings with soap emulsion have been shown by Mr. Parsons to be effective and this measure might conveniently be used where cotton is being ratooned or allowed to stand over for cattle grazing.

An explanation of this annual flow and ebb of stainers in the crop has been sought in observations on the wild host plants of the stainer, which comprise certain genera belonging to the families *Malvaceæ*, *Sterculiaceæ* and *Bombacaceæ*. Extensive surveys have been made throughout the Transvaal and rapid tours of portions of Swaziland, Zululand and Portuguese East Africa to determine the distribution of these host plants, while more intensive observations have been made on the fruiting habits and seasonal infestation by stainers of those which occur in the Barberton district. These hosts fall into two groups, firstly, herbaceous and shrubby species, secondly, arboreal species.

The first group consists of the genera *Abutilon*, *Cienfugosia*, *Gossypium*, *Hibiscus*, *Pavonia*, *Sida* and *Thespesia* in the *Malvaceæ* and *Hermannia*, *Melhania* and *Waltheria* in the *Sterculiaceæ*. A number of these species are comparatively rare, but there are several which are widespread, abundant and gregarious and on which stainers have been found breeding. The flowering and fruiting of these species are closely dependent on the rains and are consequently rather irregular. Taking the region as a whole, there is probably a continuous supply of fruit in all stages between October and May. Winter rains may produce a small out-of-season crop, though in the dry months the majority of the colonies die back completely save for those in sheltered, moist situations, where flowering and fruiting may be continuous throughout the year. *D. nigrofasciatus* is the only species regularly found on these plants: the other two species have been taken infrequently on *Gossypium* and *Hibiscus* spp.

The second and by far the more important group consists of the Baobab, *Adansonia digitata* L., and two species of *Sterculia*. The Baobab occurs in great numbers in the low veld of the Limpopo basin and extends southwards in diminishing density through the North Eastern Transvaal, petering out just south of the Olifants River.

It occurs in all types of situations but is densest on low ridges and foothills of the mountains.

It flowers during the summer and the fruits ripen off and shed during the following August and September, when they constitute the chief food supply of baboons, which appear to be the chief agency in distributing the seed and in rendering it available for insects. In detailed searches made in March, 1932, and September, 1933, no stainers were found associated with these trees.

Sterculia Rogersii N.E.Br. is confined to the Low Veld and is limited within that area to two sub-regions: (a) Outcrops of metamorphic rock forming long ridges which may break up into strings of kopjes or isolated bosses, mainly running from east to west. The extremely steep northern slopes of these outcrops, on account of the resultant exposure and broken rock masses, support a scanty xerophytic or strongly deciduous vegetation, frequently associated with Euphorbias and differing widely from that of the surrounding bushveld. (b) Much dissected country towards rivers, or low ranges of hills determining the course of the latter, subject to considerable wash exposing surface rock. The vegetation here is similar to that of the surrounding country, but added character is given to it by variations in exposure and drainage. With its enlarged, water-storing trunk, spreading roots, inconspicuous foliage and strongly deciduous habit, *S. Rogersii* is well adapted to such habitats and frequently forms large and extensive colonies where they occur. Flowering in August-September, the main crop of fruit splits open on the trees from late October onwards, though early or discontinuous rains may induce a number of partial crops. By February the seed has shed and rapidly disappears from below the trees, being a favoured food of small rodents. The following records of stainer infestation on these trees have been made in the Barberton district:—

- | | | |
|-------|------------------------|---|
| 1930. | November. | Stainers (? spp.) fighting in to trees. |
| 1931. | Mid-November. | <i>D. nigrofasciatus</i> and <i>D. intermedius</i> fighting in. |
| | Late November. | <i>D. fasciatus</i> fighting in. |
| 1932. | January. | First generation of adults of all species, <i>D. fasciatus</i> and <i>D. nigrofasciatus</i> in equal numbers, <i>D. intermedius</i> scarce. |
| | February. | Numbers of adults decreasing, second generation present as young nymphs. |
| | March. | Stainers all gone. |
| | Late October–November. | <i>D. intermedius</i> migrating to successively opening colonies. |

1933. January.

Small numbers of late instars of *D. intermedius*.

February.

Stainers all gone.

Early November. *D. nigrofasciatus* and *D. intermedius* fighting in, the former predominating.

These infestations are of the same character as those which subsequently occurred on cotton, and it is probable that trees of this species are the immediate source of the stainer infestation in cotton in the district.

Sterculia murex Hemsl. is confined to the so-called middle veld, the narrow strip of foothills and spurs to the east of the Drakensberg and Zoutpansberg between 2,500 feet and 3,500 feet, which receives its character from the fact that the mountain escarpment precipitates a higher rainfall (up to 40 inches) over this area than occurs in country immediately to the east. The vegetation might be described as orchard bush. Within this limited area the species is fairly prominent, occurring in small groups of quite large trees. It flowers in August–September, but the large and woody fruits do not dehisce until the following May. The leaves, which persist from spring to spring, are large and digitate, forming, when shed, a thick carpet below the trees. These characters, together with the rather high rain and dew fall of the region in which the trees occur, suggest that the species may be an important factor in the over-wintering of the stainer. *D. nigrofasciatus* has been found breeding below the trees in September and February and according to local information stainers migrate to them from the lands at the conclusion of the cotton crop, when the fruits are dehiscing. It is uncertain, however, whether the species is sufficiently numerous or widespread to be of more than local importance.

To sum up, it is difficult at this stage to state with certainty the relation of the three species of stainer to their wild host plants. *D. nigrofasciatus* appears to be the most catholic in its tastes and the normal infestation in cotton is probably derived from the over-wintering of an exiguous population on herbaceous hosts in sheltered habitats, reinforced by mass breeding on these and on *Sterculia Rogersii* early in the summer. *D. intermedius* is rare in South Africa, which is situated on the fringe of its known distribution. It is infrequent on wild hosts other than *S. Rogersii*, on which it commonly occurs in Portuguese East Africa and Nyasaland. *D. fasciatus* does not favour herbaceous hosts and apparently depends in this country on stand-over cotton or a large and late crop on *S. Rogersii* as a take-off for plant cotton. Its over-wintering habits are problematical, but its common association with the baobab in other parts of Africa suggests that its relationship with this species in the Northern Transvaal requires fuller investigation.

In conjunction with population records in the crop, weekly systematic records of damage to the crop have been obtained by collecting samples of splitting bolls, which have then been examined for puncturing, and graded for degree of staining. A very high degree of correlation between number of punctures per boll and percentage staining has been demonstrated. It is, however, difficult to trace any clear relation between the curves for stainer population and those for stainer activity, as measured by puncturing or percentage staining. This is due partly to the fact that estimates were made on split bolls and thus represented a summation of the damage which had been done to the bolls throughout their life, and partly to the fact that population records for adults do not truly represent the population of effective vectors of disease, since late instars as well as adults can cause infection. The fact has also to be taken into consideration that decreasing temperatures towards the close of the season differentially affect the maturation period of bolls, the growth rate of nymphs and the rate of spread of infection within the boll, thus still further distorting any relationship between the different curves. Estimates of damage based on the examination of green bolls gives a better correlation, but even so there are a number of discrepancies which can only be explained by assuming that under certain conditions stainers vary in their effectiveness in spreading disease.

In connection with the question of transmission of disease by nymphs, experiments have been made in which nymphs of different ages have been fed on bolls of different sizes. These preliminary investigations have led to the conclusion that nymphs which have not reached the fourth instar are not efficient vectors of disease, owing to the mechanical difficulty of obtaining food from bolls sufficiently advanced to provide proper nutrition.

It is, however, possible for nymphs in the early stages to survive on a diet of unopened bolls, but with heavy mortality and considerable prolongation of the stadia in those which survive.

In practice, should eggs be laid in the field before open bolls are available as food, the green bolls, by their very retarding action, would suffice to tide over a small population until open bolls were available.

In estimating damage due to staining in the manner described, no differentiation has been attempted between that due to the true fungi of Internal Boll Disease, *Nematospora* spp., and that due to other, largely bacterial, agencies. Without microscopical examination, impracticable on a large scale, it has not been found possible to distinguish the effects of different organisms causing staining.

That other organisms may play an important part was first noticed in the ratoon crop of 1931, when in the absence of stainers a considerable degree of staining occurred, which was correlated with the presence of a number of other Hemiptera, largely Pentatomidae, of which the commonest was the small *Piezodorus purus* Stål. Microscopical examination of diseased bolls, the experimental transmission of disease by exposing sterile bolls to the insects suspected and the puncturing of sterile bolls with sterile needles and the subsequent exposure of these bolls to wind-borne infection, led to the belief that in the early part of the season, when conditions are more humid, staining is caused to a considerable extent by bacterial infection present on the surface of the boll and entering it through insect punctures.

Later in the season the infection in the crop is more definitely due to *Nematospora*. Isolations of both *Nematospora gossypii*, Ashby and Nowell, and *Nematospora coryli*, Pegl, have been made from cotton bolls in the past season, but the former is more abundant than the latter. By caging adult stainers collected in the field on sterile bolls it has been shewn that all three species are capable of transmitting *N. gossypii*. In addition, adults of *D. nigrofasciatus* collected from wild cotton and from *Hibiscus vitifolius* L. in November and December, and adults of *D. intermedius* collected from *Sterculia Rogersii* in November and December and from *Hibiscus* sp. in January have all been shewn to be carrying *N. gossypii*. It thus appears that the migrants to the crop are already infected with *Nematospora*.

Experimental inoculations of sterile bolls have been made with pure cultures of *Nematospora* spp., injected hypodermically in the form of spore suspensions. The course of infection has been followed both in these bolls and in those exposed to stainer puncturing. The infection spreads more rapidly in bolls which have reached the stage where rapid growth has ceased and where lint thickening is in progress than in young bolls which are still in the stage of rapid growth, or in older bolls which are beginning to mature, dry out and split. The intensity of the infection increases regularly with the incubation period of the fungus within the boll. In neither species does the staining extend beyond the loculus in which the infection starts, nor does the fungus occur within the seed except following direct puncturing of that seed. The condition known as staining is due to the coagulation and post-mortem discolouration of the protoplasmic contents of the lumen of the lint hair. This accounts for the fact that in older bolls, where vacuolation of the lint hair has occurred, staining develops to a lesser extent following infection.

The two species of *Nematospora* vary considerably in their virulence. In the early stages of infection by *N. coryli*, when the fungus occurs in the form of short hyphal lengths and immature sporangia, the region of staining is approximately coextensive with that occupied by the fungus. In the case of *N. gossypii* the influence of the fungus extends far beyond the region where it is found, which is confined to the immediate neighbourhood of the puncture, and there is extensive breakdown and matting of the lint, which is reduced eventually to a papery membrane closely adpressed to the seed surfaces, forming a kidney-shaped loculus. In both cases, in the later stages of infection the fungus appears largely in the form of free spores, sometimes singly, sometimes in groups loosely held together by their appendages, and these spores are distributed throughout the whole loculus.

The extension of the staining beyond the region occupied by the fungus suggests that the death of the lint hairs is due to a toxic substance liberated by the developing fungus. Bolls inoculated with a sterilised centrifuged suspension of a pure culture of the fungus developed staining which was indistinguishable from that produced by the living organism. This was very much more marked in the case of the toxic solution prepared from *N. gossypii* than in that from *N. coryli*, whilst control inoculations of sterile water produced no symptoms of disease. It thus appears that the fungi of stigmatomycosis may produce their effects in the manner suggested.

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, MAGUT, NATAL FOR THE PERIOD 1930-1933.

BY

P. A. BOWMAKER.

INTRODUCTION AND SUMMARY.

In the compilation of this Report, which covers the work of the three seasons 1930-33, it is unfortunately not possible in some directions to record much progress, as work during the first two years was seriously hampered by bad weather conditions. References to this have already been made in the summarised reports contained in the two previous volumes, and it is intended here to include a summary of work carried out previous to the last season in such cases only as results justify. Details, however, are given of the work of the 1932-33 season wherever a satisfactory conclusion has been reached.

For the three years under review, owing to combinations of drought and bollworm, the results of cotton experiments have been disappointing, but the yields of the comparatively short-period rotation crops have been encouraging, and results on the Station have largely influenced cotton growers in keeping land under cultivation in the district. During the last season the total rainfall, while being up to the average for the district, was sufficient for all requirements until the end of December only, after which periods of drought were experienced. This had an important bearing on the interpretation of results.

Until the end of December conditions for germination and early growth were ideal. The style of root system developed, however, encouraged by the good conditions in the early period of growth, unfitted the plants to withstand the periods of drought experienced later in the season.

The Station soil, which represents a fairly large proportion of the cotton land in the district, varies in depth from 8 inches to 18 inches and lies directly on an impervious blue shale. Most of the land slopes more or less steeply. Thus there is very little moisture present at the beginning of the season after the winter drought. Only a small part of the rain in January was effective, as the soil had become so dry that moisture penetration was difficult, and in addition the rain was of a violent nature. For a short time during February the soil was air dry to its full depth. This dry period, lasting in effect for about two months, was also exceptionally hot.

The cotton crop grown under such conditions was poor. Practically no crop was set after the middle of January. Although flowering was profuse during February and March, young bolls formed in this period failed to mature. A slight stimulus was, however, given by the rains late in February and March, of which mention is made in the discussion of the cotton variety test for 1932-33.

Results of the cotton experiments are not given in detail as, owing to insect pests and weather conditions, none has been carried to a satisfactory conclusion. It may be stated, however, that the variety tests have been carried out in conjunction with a seed multiplication programme, and fair multiplications of all strains under test have been made each year. In the last year fair quantities of seed were obtained from multiplications of some of Parnell's strains not yet available in sufficient quantity for testing purposes. Work on cotton generally is being carried out with strains which have been evolved from U.4 at Barberton. From a considerable number of these, eleven were chosen to be included in the variety trials of the 1932-33 season. A small plot of Zululand Hybrid is also planted annually for jassid observations. No really definite results of cotton experiments can be reported for the three years under review.

Maize is being given greater attention than formerly. The importance of this crop is stressed in the Report both in connection with farming economy and with the control of American bollworm. It is too early to anticipate results, but the obvious individuality of the bulks in the first year of selections leads to the belief that a great improvement in American White Flint, the maize variety considered the most suitable for Low Veld conditions, is possible. Groundnuts and Tepary Beans have given good yields for three years in succession. Many enquiries, prompted by good sales on the local markets, have been made regarding the method of handling the groundnut crop on the Station.

Seed multiplication of varieties and strains of all crops on the Station has been effective and quantities of seed have been stored each season for the seed requirements of the district.

COTTON.

Work on cotton has consisted of trials of the strains evolved at Barberton, multiplication of these strains, insect pest observations, spacing trials and manurial experiments. It is felt that time-of-planting experiments are of little practical value, as time of planting in most seasons is dependent entirely on rainfall; such experiments have therefore been discontinued.

Variety Test 1932-33.—Of the 18 strains included in the test of the previous season, 11 were chosen for test with U.4 in 1932-33. These strains resulted from single plants selected by Parnell in 1929, and the trial was laid out on similar lines to others, as arranged by Parnell. Planting was carried out on November 10th under almost ideal conditions for germination, the usual spacing of 3 feet 6 inches by 2 feet being adopted. Plots of 60 feet by 4 lines were used in place of 45 feet by 4 lines which had been customary previously, as it was believed that the longer plot would tend to minimise differences in yield due to the small areas of irregularity found in the Station soil. The randomized block method of comparison was used, the layout allowing of 10 sets of plots.

Growth conditions continued fair until the end of December, when flowering was commencing. Until February 19th a period of exceptionally hot, dry weather was experienced, with one rain in January upon which comment has been made above. The rains following in late February and March were not sufficient to revive the plants, with the result that, while flowering was stimulated, plants were unable to bring the young bolls to maturity. The test, instead of being a comparison of the true yielding powers of the strains, thus became a demonstration of relative earliness.

Varietal yields are not included, but it may be stated that the early, non-vegetative types gave the best yields—320-355 lbs. seed-cotton per acre—and U.4 bulk was last with 250 lbs. per acre.

Multiplication of Strains, 1932-33. Seed of most of the strains included in the Variety Test was available for multiplication purposes in sufficient quantity for planting by machine.

Planting was completed about a month earlier than in the Variety Test, and as a result of the extra month of growing weather a much heavier growth of wood was noticed. Picking was completed on April 10th, the resulting yields being very similar to those of the Variety Tests.

Observations on the strains which were under trial, and which have been grown on the Station for two years, indicate that although the quick maturing types are desirable, in general they lack vigour and ability to make a fresh effort to fruit, should the first crop be lost through insect attack or weather conditions.

Spacing Experiments.—Spacing trials have been attempted for three seasons, only the last one, however, being carried to a conclusion. March infestations of American bollworm so reduced crops of the first two seasons that yield figures would have been worthless. The strain U.4/4 was used as representing a medium style of plant among Parnell's re-selections. The randomized block system was used for comparison,

with 9 sets of plots. The standard width of 3 feet 6 inches between rows was kept throughout, the spacings compared being 12 inches, 18 inches, 24 inches and 30 inches within the rows.

The experiment was planted on October 5th and as with all cotton the crop picked represented only early bolls. No recovery took place in response to the February–March rains in any spacing, the final picking being made in mid-March.

TABLE I.
SPACING EXPERIMENT, 1932–33.

<i>Spacing.</i>	<i>Yield seed-cotton in lbs. per acre.</i>	<i>Difference for P=.05</i>
12" × 3' 6"	460	71
18" × 3' 6"	455	
24" × 3' 6"	384	
30" × 3' 6"	373	

The figures are purely a demonstration of the earliness induced by the closer spacings. In spite of this it is thought that, where weather conditions are so erratic as in the Magut area, very close spacing is not to be recommended. Should a loss of crop occur from any cause, closely spaced plants are not able to set a fresh crop.

Rotation Experiment.—The first part of this trial was carried out in the season 1931–32, and was designed to test the after-effects of the various rotation crops on cotton and on each other.

A field roughly 4 acres in extent was divided into 6 blocks, the divisions running North and South, and each was subdivided into 5 plots. Maize, Soya Bean, Sunflower, Sunnhemp for green manure, and Groundnuts were randomised within the larger blocks. Each plot was 18 feet by 300 feet, an arrangement which permitted of ploughing in the green manure in a normal fashion.

During the 1932–33 season the field was subdivided into five, with the division running East and West, and planted to cotton and rotation crops in strips.

The experiment is open to the objection that the final plots were too narrow to allow for the outside row effects of the previous year's cropping. This objection is rather borne out by the yield figures shown in Table II. Yields of the rotation crops for 1932–33 taken from this experiment are dealt with under their respective crop headings.

TABLE II.
COTTON YIELDS FOLLOWING ROTATION CROPS.

<i>1931–32 Crop.</i>						<i>1932–33 Cotton Crop in lbs. seed-cotton per acre.</i>
Soya Bean	...	...	...	...	...	186
Groundnut	...	...	...	...	...	174
Maize	...	...	...	...	...	170
Sunflower	...	...	...	...	...	161
Sunnhemp	...	...	...	...	...	158

Owing to bad germination the cotton had to be replanted. This was effected on November 11th. U.4/4/2 was used for test as it was hoped to take advantage of its early maturing property. The yields shown above give no significant differences as the effect of previous cropping.

The experiment has been redesigned and it is hoped to carry on the new arrangement of plots for a number of years. Attention is being directed to the effect of rotation crops on cotton only, work on the after effect of each rotation crop being discontinued.

Six crops are being tested for their effect on cotton, viz.:—Sunflower, Groundnut, Maize, Soya Bean, Sunnhemp and Tepary Bean. Individual plots are roughly square and of about 1/35th of an acre, after allowing for a margin for outside row effect. There are eight replications. The experiment was planted on December 6th, and fairly representative yields of all crops with the exception of Soya Bean were harvested. Owing to the practical difficulty of ploughing in the Sunnhemp as a green manure, the crop was carried on for seed and the results of the green manure experiment, of which the commencement is described below, are to be used in the interpretation of the cotton results next season.

Superphosphate Trials.—Both the effect of immediate applications of superphosphate and the residual effect, following application to the maize crop, were the subject of experiment.

The application of dressings of superphosphate at various rates, while it has only been carried out on an observation plot scale, has given no apparent increase in yield of cotton in past seasons. It was thought that possibly this was due to the method of application—broadcasting before planting—being at fault, as it would not allow of sufficient soil penetration under poor rainfall conditions. In the experiment for the 1932-33 season, superphosphate was ploughed in in September at the rates of 200, 400 and 600 lbs. per acre, with control plots of no manure, using the randomised block basis of comparison, with eight repetitions of each dressing.

No difference in growth or yield could be attributed to superphosphate. The yields resulting from the various dressings are shown in Table III.

TABLE III.
SUPERPHOSPHATE TRIAL 1932-33.

<i>Dressing of superphosphate in lbs. per acre.</i>	<i>Yield of seed-cotton in lbs. per acre.</i>
200	441
400	418
600	407
Control (no manure)	419

In the summarised Report for the 1931-32 season mention was made of an increase in yield in maize due to a heavy dressing of superphosphate. The area on which this experiment was carried out was cropped with cotton in the 1932-33 season, and observations were made during growth and on yields for any residual effect of the superphosphate which might be present.

Planting with U.4/2, a strong growing, late type, was effected on October 31st. Early growth was slightly better on those plots which had been manured the previous year. The final yields were 321 lbs. per acre of seed-cotton from the phosphate plots, against 278 from the others. The difference, however, proved to be far from significant.

Judging from results up to date it does not appear likely that the direct application of superphosphate to the cotton crop is going to enter into farming practice in the Magut area, but the experiments will be continued as the recent seasons cannot be accepted as normal.

INSECT PESTS.

The Magut Station is now being used to a greater degree as a centre for the collection of information for use at Barberton concerning the bollworms and stainers. In connection with attacks of American bollworm, weekly egg collections have been made, when possible, from cotton and maize, for information concerning the actual relationship between these crops as host plants. It was also decided to obtain information on the amount of natural egg-parasitism present during the season.

Stainer work was intended to fix definitely the time and rate of influx of three species of *Dysdercus* by means of weekly counts, the results being used for comparison with infestation rates found in other parts of the cotton belt.

American Bollworm.—The losses of squares and bolls in March, 1930-31 and 1931-32 seasons due to the American bollworm were very severe indeed, and the egg counts taken during 1932-33 indicate that there is probably a close relationship between maize and cotton and losses of cotton caused by American bollworm. In the previous summarised Report a recommendation was made that maize should be planted in *small* areas as *often* as rainfall conditions would allow. This was suggested, not as a means of control of American bollworm, but purely as an insurance against adverse weather conditions, and in the 1932-33 season the practice was followed on the Station.

Fairly intensive observations have shown that the bollworm moth has a definite preference for a maize plant as a host for egg laying,

provided that the stage of development of the plants is suitable for the young worms on emergence. It is probable that the fact of there being on the Station throughout the 1932-33 season a crop of maize in an attractive state accounts for the practical absence of egg-laying on the cotton. Thus, apart from the aspect of insurance against weather, it appears that the practice of serial maize plantings is likely to play an important part in the control of American bollworm.

In the season 1932-33, infestations of eggs were noted for the first time on 14th March. Five collections were made, from 50 plants each, of maize and cotton, at weekly intervals, and the eggs were kept singly for observations on egg-parasite emergence. The results are given in Table IV.

TABLE IV.
AMERICAN BOLLWORM EGGS FROM 50 MAIZE PLANTS, AND PARASITE EMERGENCE.

Date Collected.	Number of eggs.	Date parasites emerged.	Number of eggs parasitised.	Number of parasites per individual egg.
16.3.33	124	23.3.33	3	3, 2, 3,
22.3.33	237	29.3.33	4	3, 4, 2, 1
		30.3.33	3	2, 3, 3
		31.3.33	1	2
30.3.33	59	5.4.33	3	2, 3, 4
		6.4.33	1	2
		10.4.33	1	2
7.4.33	37	None	—	—
14.4.33	18	None	—	—

It will be noted in the above Table that on 22nd March the egg-laying averaged 4.7 per plant. The egg-laying on cotton at the same time, and also throughout the season, was negligible. The egg-parasites were not identified.

Stainer (Dysdercus spp.).—No collection of statistical information concerning stainer was attempted before 1932-33 season. The object of this work is given in the Insect Pest Control section of the Barberton Report. It may be stated briefly, however, that Mr. Pearson visited the Station in February and arranged for collections to be made on precisely similar lines to those made elsewhere, with the object of correlating stainer influx with the fruiting periods of certain known wild host plants.

A tour was made through the Natal Low Veld and Zululand in an attempt to locate specimens of host plants known to be in abundance in the Transvaal and further north. Only one tree, a species of *Sterculia*, was found, with no evidence to show that it had been carrying stainer, and the source from which stainer infestations migrate to cotton in Natal is still unknown.

Actual figures of counts are not included in this Report. A summary of the position in 1933 is that infestation opened about 20th February with *D. nigrofasciatus*, which increased steadily from that date. Small

numbers of *D. fasciatus* were found, but damage to cotton by this species was not heavy until the end of March when there was a sudden influx of adults.

Beetle (Syagrus rugifrons).—The control measures which have been described in "Reports from Experiment Stations, 1929-30" have proved satisfactory. Where, for practical reasons, it was found necessary to plough across the lines of trap strips no difficulty was found to attend "jumping" the plough over the strips each time they were encountered. A certain percentage of the plants was trampled out, but sufficient remained to act as an effective trap.

Emphasis has to be laid on the need for close observation on the state of the young growth in traps. In a heavy infestation a great number of beetles may be killed by one dusting with calcium arsenate and it may be thought that the pest is under control. Usually it will be found that at least a second dusting will be necessary, otherwise a sufficient number of beetles will remain to act as a focus of infection. At the time when the beetle is most active, *i.e.*, from mid-December to mid-January, the rate of growth of the trap provides non-poisonous food in a very short time. The beetle feeds on the youngest growth and it is this that has to be kept poisoned systematically.

A definite migration to cotton previously free from beetle was noted for three days after the heavy rain in January, 1933, when practically every bush was found to harbour a pair.

ROTATION CROPS.

MAIZE.

Selection Work.—The need for a more reliable strain of maize for use in cotton-growing districts has become more apparent during the last two years of financial uncertainty, as a measure of reducing general farming costs, and also in connection with bollworm control as has already been pointed out. Until recently it was usual for a large proportion of the maize, the staple food of labourers employed in cotton-growing, to be imported from the High Veld, but recent irrigation developments in the Magut area will probably make the local supply sufficient to meet the requirements of the district. In spite of this permanently lowered local value of maize, it is thought that the evolution of a more drought-resistant type will enable the dry-land cotton farmer to grow his own supplies on a sound economic basis. In addition to its importance as a food crop, maize appears to be a most suitable crop for use in rotation with cotton as regards their mutual after effects.

The commercial variety known as American White Flint was considered to offer the most suitable material for selection purposes, as it has given good results as a drought-resister in many places, but is mixed and contains many apparently undesirable types. An effort is being made to purify a number of types to a certain degree; subsequent observations on the types are to determine what is desirable.

No attempt is being made to produce pure lines in the sense that the term is used by the geneticist. From a number of cobs from a field of $2\frac{1}{2}$ acres grown in 1931-32, which suffered very severely from drought, a selection was made from the very small proportion which was well filled, as representing different grain types. Each cob gave sufficient seed to plant $1/10$ th of an acre. Square plots were set out with the object of taking single cobs more or less from the centres of the squares in the 1932-33 season. The seed of these would probably be the result of either self-fertilization or fertilization by closely related pollen. This procedure will be carried on for several seasons with a large number of selections, and while a certain degree of purity should result, some of the objections to controlled self-fertilization may be overcome. The very definite way in which certain plant and cob characters are inherited, as shown in the single cob plots from these first selections, which were not necessarily the result of close breeding, lead one to expect that some success should follow the method.

An important consideration in maize-growing is the state of the weather at the time of flowering. Failure of the crop under conditions of drought is frequently due to bad fertilization. In dry periods the silks often emerge too late for pollination and complete loss of crop may result. Any improvement in this direction would undoubtedly render maize a much safer crop than it is now in areas of uncertain rainfall.

The plots were sown on 29th December, 1932, and for the primary selection, based on the emergence of silk in relation to the pollen condition, weather conditions were very suitable. By the 14th-15th February free flowering of the males in all families was taking place, following the very dry period, and while 10 per cent. of one lot was "silking" others were showing no signs even of cob sheaths.

The characters noted, in addition, for a number of plants and families were—liability to sunburn, suckering, streak disease, stockiness or otherwise of plant, laying, weight and shape of cob, colour and mealiness of grain.

Observations on Commercial Varieties.—The value of a variety of maize for conditions found in the cotton districts is not necessarily

its cropping power in the sense of yield obtainable under fair rainfall conditions. Ability to make growth during dry periods, and more particularly to be able to silk freely with but small moisture stimulus is thought to be of greater importance.

In order to get a true idea of this quality in several varieties known to be drought-resistant and commonly grown in the district, it was decided to plant small observation plots whenever rainfall conditions during the 1932-33 seasons offered the prospect of a good germination. As has been pointed out, cropping power depends largely on rains at the time of flowering, apart from any inherent quality, and the arrangement of serial plantings obviated the great disadvantage of using one set of observation plots, where difference in growth period might place one variety ahead of others because flowering happened to coincide with rains.

The varieties under observation included American White Flint, a strain of Hickory King which has been grown in the cotton district for some years, Anveld, White Wisconsin, 60-day White Flint and Red Peruvian, and in addition a few seeds of each of the cob selections of American White Flint which have already received mention. Plantings were made on November 9th, November 18th, November 26th, December 3rd, December 19th, and January 20th.

All varieties in the first planting behaved well, but on other planting dates, with the exception of the last which gave a failure in all varieties, the superiority of American White Flint and to a lesser degree Anveld and 60-day White Flint, was obvious.

Maize Suckering Experiment.—The production by maize plants of more than one stem, seems to be mainly a genetic character, but the extent to which these suckers are developed depends on environmental conditions. Certain varieties are known to be more liable to produce suckers than others, and it is a common practice where these are grown to remove suckers when the plants are 4-6 weeks old. While the practice is probably effective in reducing transpiration in dry periods, it is thought that it must also have some effect in reducing the rate of carbon assimilation for grain formation.

In the 1931-32 season an experiment was laid out to test the value of removal of suckers, using the variety American White Flint, but as suckers were only sparingly developed, and the resulting crop was not affected, the experiment was repeated in 1932-33. The experiment was planted on November 29th, and reference to the rainfall chart will show that subsequent weather conditions were ideal for purposes of showing up any effect which could be attributed to suckering. The commonly grown varieties of maize are mixed as regards the number

of plants bearing suckers, the proportion being generally relatively small; for this experiment, therefore, 60-day White Flint, which suckers very freely, was used.

Comparison of suckered *v.* non-suckered plots was made by the use of the half drill strip method. Removal of suckers was carried out on January 4th at the beginning of the dry period and about a week before flowering was general.

A smaller amount of mid-day wilting was noticed in those plots which had had suckers removed.

The cobs were picked on March 10th with a yield of 927 lbs. per acre. No difference in yield resulted from the removal of suckers.

Superphosphate Trials.—No accurate qualitative experiment to show the effect of superphosphate on maize was attempted for the 1931-32 season. It was thought that, in view of the lack of increased returns from the application of superphosphate to cotton, and the lack of available phosphate in the soil as shown by conventional analysis, application of superphosphate to the maize crop, to be followed by cotton in the succeeding year, might give better results.

The superphosphate experiment for 1932-33 on cotton has been described. It is intended to carry on for several years a combination experiment of direct application and residual effect of superphosphate on both maize and cotton in rotation.

A note was included in the summarised Report, 1931-32, on an increased yield of maize following a very heavy dressing of superphosphate. This experiment was purely qualitative, and the increased crop did not pay for the cost of manuring. In the seasons following, a quantitative experiment was laid out in a manner similar to that described for the superphosphate experiment on cotton, and planted to maize on January 23rd. Unfortunately a very poor and irregular stand resulted so that plot yield figures would have had no value.

The rows were interplanted later with Tepary Beans in an effort to level up as much as possible the amounts of phosphate drawn from the different plots in order that the land could be used for residual effect in the season 1933-34 on cotton. A crop of mixed grain of 615 lbs. per acre was taken.

GROUNDNUTS.

Yields from groundnuts in the three seasons which are being reviewed are decidedly encouraging, and it is felt that definite progress has been made towards the selection of the variety most suited to Magut conditions.

Work in 1930-31 consisted only of observation and multiplication blocks of the 5 varieties, Barberton Strain (from Gudiatham Bunch), Spanish 9, Natal Ordinary, Virginia Bunch and Japanese. The first three are very similar in appearance and growth, giving a small two-kernelled nut. Virginia Bunch is a very much larger nut with three to four kernels and commands a slightly higher price. Japanese is a small two-kernelled nut notable chiefly for its high oil content.

Variety Trials.—In the variety trial in 1931-32, Virginia Bunch was not included, but observations from small multiplication areas indicated its definite inferiority for growth under adverse conditions. Yields of 650-700 lbs. per acre of unshelled nuts were obtained, as has been reported. A full variety trial was planted in 1932-33, and the same three varieties are found at the head of the list as in the previous year.

The varieties were compared in a randomised block test with 8 replications. Plots of 1/66th of an acre were used, with a spacing of 1 foot between plants and rows 2 feet 10 inches apart.

The experiment was planted on December 29th and a very good germination resulted. Reaping had to be delayed until May 19th, when all varieties were fully ripe, but was concluded satisfactorily. The yields are given in Table V.

TABLE V.

<i>Variety.</i>	<i>Yield of unshelled nuts per acre—lbs.</i>	<i>Difference for P=·05.</i>
Barberton Strain	1,272	104
Natal Ordinary	1,173	
Spanish 9	1,155	
Japanese	989	
Virginia Bunch	810	

The first three varieties are all later than Japanese and Virginia Bunch, and it is probable that the very much lower yield of these may be due in some measure to weather conditions inhibiting flowering, while rains a little later came at the right time for the flowering of the other varieties.

Multiplication of Seed.—Multiplication areas for seed requirements, of the varieties under test, were planted, and the resulting yields are summarised in Table VI.

TABLE VI.
MULTIPLICATION OF GROUNDNUT VARIETIES.

<i>Date Planted.</i>	<i>Variety.</i>	<i>Yield unshelled nuts per acre—lbs.</i>
15.11.32	Virginia Bunch	1,130
7.12.32	Barberton Strain	1,998
7.12.32	Spanish 9	1,710
7.12.32	Natal Ordinary	1,686
7.12.32	Japanese	1,174
30.12.32	Barberton Strain	1,225
30.12.32	Spanish 9	1,215
30.12.32	Japanese	922

In the plantings made on December 7th, the first portion of the crop was filled by the rains of January 19th. Later rains, when this crop had partially dried off, caused a certain amount of splitting and consequent discolouration, particularly with the Japanese variety.

Rotation Experiment.—The previous treatment of the land on which this experiment was carried out has been described under cotton experiments. Groundnuts were planted on November 28th, the Barberton strain being used. The results are given in Table VII.

TABLE VII.
EFFECTS OF OTHER CROPS ON SUBSEQUENT GROUNDNUT YIELDS.

Crop 1931-32.								Yield of unshelled nuts in lbs. per acre
Maize	...	...	...	...	...	...	...	1,482
Soya Bean	...	...	...	...	...	...	...	1,322
Sunnhemp G.M.	...	...	...	...	...	...	...	1,280
Groundnuts	...	...	...	...	...	...	...	1,250
Sunflower	...	...	...	...	...	...	...	1,220

Cultivation Trials.—For the two seasons 1930-31 and 1931-32, experiments were laid out comparing ridged *v.* flat cultivation. No increased yield could be attributed to ridging, and the experiment is not being continued. Flat cultivation is being used in all work with groundnuts on the Station.

TEPARY BEANS.

Experience of Tepary beans indicate that they should find a place as a rotation crop with cotton. Although under adverse conditions crops have been poor, on no occasion have they been a failure on the Station. It is also encouraging to note that an increasing interest is being taken in this bean as rations for native labour.

It frequently happens that a farmer finds himself unable, owing to poor moisture conditions, to plant the whole area which has been prepared for other crops, and it is thought that some return can always be obtained in such cases from a late planted crop of Tepary beans.

Yields of dry beans and of hay at various spacings for the 1931-32 season were given in the summarised report for that year. In 1933 no accurate field trials were attempted, work being confined to general observations.

Four blocks were planted on the Station in 1933, each of them late in the season and with different previous treatments. The yields were not good, as rainfall conditions subsequent to planting were so poor. Two blocks were sown on January 25th. The first was on a very shallow soil, and gave a return of 294 lbs. per acre. The second had been fallowed for five months following a previous cotton crop and gave 590 lbs. per acre. Planting of the second two blocks was effected

on February 22nd. The first of these had been under a ratoon crop of cotton which was pulled out early in February owing to the numbers of early stainer found breeding there. Beyond a grubbing the block received no previous cultivation and a yield of 494 lbs. per acre was taken. The second block had similar treatment, following a crop of Lima bean which had failed, and returned 343 lbs. per acre. The crop was ripe in each case 11 weeks from the date of planting.

SUNFLOWERS.

Work on Sunflower during the first two seasons was confined to growth observations on two varieties—Bremersdorp Black and Striped. Spacing trials were successfully carried out during 1932 and 1933, and during the latter season a variety test with strains evolved at Barberton was attempted, but had to be abandoned. Experience with the crop has shown that with soil conditions as they are at present on the Station the limiting factor on growth is rainfall. In 1931 the crop was planted in January and only very inadequate rain came after this date. The crop only grew to a height of 3 feet and the yield taken in May averaged 254 lbs. per acre. The following year late conditions for growth were fair, and yields of about 950 lbs. per acre resulted. In the last season planting was effected in December, and while growth was fair, late rains were not sufficient for the requirements of the plant.

Variety Test, 1933.—The variety test of 6 strains evolved at Barberton had to be abandoned on account of a poor germination. It may be mentioned that in conducting a sunflower test it is essential that a good germination be obtained at the first planting. Growth in the early stages is rapid, and the drain on soil moisture so great that refills cannot compete against the older plants, even should the difference in age be as little as a week.

Spacing Trials, 1932 and 1933.—A standard width of 3 feet between rows was used, the spacings of 3 feet, 2 feet and 1 foot within the rows being compared. The experiments were planted on February 5th, 1932, and December 29th, 1932, and the comparison was made by use of a randomised block system with 10 replications, one guard row being left on each side of each plot. The actual size of plots from which yields were taken being 1/60th acre.

TABLE VIII.
SUNFLOWER SPACING TRIALS.

Spacing.	Yield in lbs. per acre.		Difference for P = .05.
	1932.	1933.	
3' × 3'	930	611	26
3' × 2'	933	606	
3' × 1'	906	552	

The above table shows a significant drop in yield in the close spacing in 1933.

The weather conditions during the growing period in each case were such as to force the plants to take advantage of all available moisture. Until the rains of February 1933 the 1' and 2' spacings were showing signs of distress, and doubtless the wide spacing would have shown to greater advantage had rains failed to materialise then. Larger, better filled heads resulted from the wide spacing. The indications of the experiments are that still wider spacings should be included in future spacing trials.

Rotation Experiment.—The previous treatment of the land for this experiment has been described in the cotton section of this Report. Yields from the different treatments are given in Table IX.

TABLE IX.
EFFECTS OF OTHER CROPS ON SUBSEQUENT SUNFLOWER YIELDS.

Crop, 1931-32.						Yields of sunflower per acre—lbs.	Difference for $P=0.05$.
Soya Bean	...	...	...	...	...	935	137
Maize	...	...	...	...	...	855	
Sunn hemp green manure	...	...	...	...	...	800	
Groundnuts	...	...	...	...	...	764	
Sunflower	...	...	...	...	...	677	

Planting was completed on 28th November and good germination resulted.

LIMA BEANS.

Lima beans have been grown on a field scale only in the two last seasons of the period which is being reviewed. Results in 1933 gave a reversal of opinion as regards the suitability of the crop to the district, as yields such as were reported in the summarised Report for 1932 were not again obtained.

In the first season the area under this crop was confined to a small observation plot. Field scale work was attempted in 1932 and 1933, but no accurate cultivation trials have been accomplished. In 1932 part of the crop was lost through C.M.R. beetle damage and, to avoid a repetition of this, early planting (10th October) was carried out for the 1933 crop. A yield of 172 lbs. per acre of very inferior quality beans was reaped. The behaviour of this season's crop, and previous observations, indicate that a very special set of weather conditions is necessary for success with Lima beans. As climatic conditions are so uncertain in the Magut area, it is not likely that this type will enter into any definite scheme of rotation which may be adopted. Late plantings are to be made in any future work which is attempted.

SOYA BEAN.

Heavy yields of soya beans were obtained in the season 1929-30. For the three seasons under review the crop has been a failure. Growth has been good, with free nodulation, until flowering time, when each year premature ripening has taken place as a result of dry conditions.

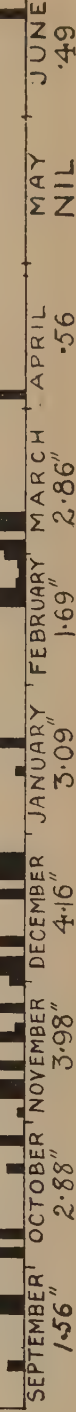
ENSILAGE.

Two pits of ensilage were made in 1932 to be kept over for use when required. Mapira, a species of sorghum, was used, and an average crop of $27\frac{1}{2}$ tons green weight per acre was taken after five months of growth. The pit was opened in August 1933 and was found to be an excellent quality sour ensilage with a negligible amount of loss through rotting. Winter condition of cattle is a matter of importance in the district and great interest has been shown in the results of feeding cattle in winter time on the Station.

MAGUT EXPERIMENT STATION, SEASON 1932-1933.

RAINFALL IN TWO-DAY TOTALS. TOTAL FOR SEASON 21.27".

4"
3"
2"
1"



SWAZILAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATIONS AT BREMERSDORP AND INGWAVUMA FOR THE SEASON 1932-1933 AND GENERAL REVIEW OF RESULTS TO DATE.

BY

J. V. LOCHRIE.

INTRODUCTION.

Climatic Conditions.—From the point of view of the general agriculture of the country, the season 1932-33 has been the most difficult on record, characterized by low and badly distributed rainfall and by the low prices obtainable for farm produce. The season was short, with delayed arrival of the spring rains in some areas and long periods, accompanied by hot dry winds, during the growing season. In this respect the Experiment Stations were fortunate in receiving good early rains and the rainfall charts thus do not reflect the general rainfall conditions. In addition, the rains closed early, practically no further falls occurring after the beginning of March. The delayed spring rains, and the poor condition of work-oxen after the dry winter, prevented early ploughing and some of the proposed cotton acreage could not be got ready for planting. This factor, added to the uncertain currency position, considerably reduced the acreage planted to cotton.

Pests and diseases.—Apart from losses directly attributable to the climatic conditions, yields were affected by damage from bollworm and to a slight extent by stainer-carried bollrot. As in the two previous years, Red Bollworm (*Diparopsis castanea*) was of greater importance than American (*Chloridea obsoleta*), the latter being present in the early part of the season only.

GENERAL SUMMARY OF RESULTS.

Cotton.—(1) In trials of selected strains of U.4 over a number of seasons at both stations, the majority have proved higher yielders than U.4 bulk. Some strains in particular, such as 920, 9243, 9355, etc., have been consistently successful under all conditions experienced during the period of the trials.

(2) The results from experiments on spacing have afforded very few reliable data. At Bremersdorp under satisfactory moisture conditions close spacings have given the highest yields, while under the drier

conditions in the south no significant differences between any of the spacings have been obtained.

(3) Significant decreases in yield followed delayed thinning of the crop at Bremersdorp and Ingwavuma. The fall in yield was more pronounced where the plants were thinned to a fairly wide spacing.

(4) Cotton planted after bare fallow and also after a crop of buckwheat ploughed in made very poor growth in the early part of the season, compared with that of cotton following sunnhemp ploughed in, maize, beans and groundnuts. Later, growth following the former two treatments improved, and eventually exceeded that on the other four series. There were no significant differences in yields between any of the treatments but the crop following fallow and buckwheat was a good deal later in maturing.

(5) No significant differences in yield have been found from applications of phosphates or potash. The plant development on plots receiving potash was slightly later than on the unfertilized and phosphate plots.

Rotation crops.—(1) Increases in yields of maize, beans and groundnuts followed applications of phosphates while, of the three crops mentioned, maize was the only one to give higher yields on the plots to which lime had been applied.

(2) Under good moisture conditions at Bremersdorp maize gave significantly higher yields at a spacing of 12 inches in 3 feet rows than from closer and wider spacings. Under the drier conditions in the low veld considerably wider spacings appear best.

(3) Maize planted after the same treatments as the cotton referred to in (4) above also showed very poor growth following bare fallow and a green manure crop of buckwheat compared with the others. The yields of grain following maize, beans, groundnuts and sunnhemp were significantly higher than that obtained after fallow.

(4) Except in the more favoured districts, maize yields are poor and, as it is considered that this is due in part to the growing of unsuitable varieties, a number of different types have been tried. Of these, some white and yellow flint types are promising.

(5) With the distribution of varieties of higher yielding capacity, groundnuts are proving one of the most suitable rotation crops, particularly in the low veld. In tests, a Spanish variety has consistently given higher yields than the Virginia Bunch commonly grown. Except under excellent rainfall conditions, the latter does not fill well and a high proportion of the kernels is shrivelled. During the present season a variety from Barberton and a selection made locally outyielded Spanish, which had been the best in previous years.

(6) Bean crops on the whole have been disappointing owing to unsuitable climatic conditions and to damage by beetle. A yellow soya, which is not affected by C.M.R. beetle has been the most successful at Bremersdorp, while fair yields of Tepary beans are obtained. In the south, successful results are obtained by winter planting under irrigation. Considerable increases in yield of soyas were made by drilling in 15-inch rows compared with 30-inch rows.

EXPERIMENTAL STATIONS.

Owing to the losses caused by drought, duststorms and hail during the past few seasons the experimental work has been severely handicapped, but the replication of as much of the work as possible at various centres each season has reduced the possibility of a total loss in any season.

Bremersdorp.—The station was again fortunate in receiving much better rains than the country generally. The good falls of September and early October made it possible to get the land ploughed early and all the cotton was planted in early November under exceptionally good conditions. Early growth was good, but on December 2nd a violent hailstorm occurred and all the experiments were destroyed. Re-planting was done as soon as possible, but fared no better, as a sequence of duststorms towards the end of the month finished off practically everything. The few plots which survived never recovered sufficiently and yields were low, and unreliable for comparative purposes. The season was still early enough for crops other than cotton, however, and experiments with various rotation crops were planted. Conditions were good during the next three months and high yields were obtained from these.

Ingwavuma.—The rains broke much earlier than in the preceding season and cotton planting was completed by the middle of November under good conditions. Ample rains continued during the early part of the season and this, combined with a fairly heavy bollworm attack, resulted in big growth. Except for one fall towards the end of February, no further effective rains were received and a considerable amount of the crop was shed in addition to that lost by bollworm. With a continuance of the dry conditions the plants did not recover and reliable comparisons of yield could not be made.

Nsoko.—As in the previous year, some of the experiments were planted on the irrigation area at Nsoko. In view of the losses by bollrot in the previous season it was decided to confine the irrigation to a heavy watering some time before planting with the object of creating a reserve of moisture. The land received a 6-inch watering in

mid-October and planting was completed on the rains of early November. As will be seen from the rainfall chart the rainfall was substantially the same as at Ingwavuma but loss by bollworm was less. In spite of the low rainfall in the latter part of the season, the crop stood up well, the average yield being just over 800 lbs. seed cotton per acre. Stainers were present in the cotton early, but bollrot infection was slight compared to the previous season.

Variety Tests.—Certain of the less promising strains grown in the tests in previous years were discarded and two new strains introduced, making a total of 11 for trial, together with U.4 bulk. With the decrease in the numbers on trial it was possible to increase the number of plot replications to 12 at all three centres.

For reasons mentioned earlier in the report the only successful trial was that at Nsoko. The test there was planted on November 5th after the land had received a heavy watering. Owing to loss of stands through attacks of grasshoppers when the plants were small a good deal of refilling was necessary. The rains of November and December were good and early growth, though somewhat irregular owing to the refilling, was excellent. Loss by bollworm—almost entirely red bollworm was slight and the plants were able to set a fair early crop. The rains practically ceased in late February, but the plants held on well and satisfactory yields were obtained. The season, with the slight bollworm attack in the early part and the quick close of the rains, was more favourable to the early strains such as 998 and 955.

The results of the test are given in Table I. which summarizes the yields obtained in the trials during the past three seasons.

TABLE I.

The yields of the strains are given as percentages of the mean lint yield of U.4 Bulk in each trial.

Strain.	Bremersdorp.		Ingwavuma.	Nsoko.	
	1930-31.	1931-32.	1930-31.	1931-32.	1932-33.
U.4	100	100	100	100	100
920	114.9	108.7	110.7	121.9	102.4
9243	119.9	104.2	127.1	117.3	99.8
U.4/4	107.1	102.2	104.3	138.3	103.0
921	113.6	105.4	95.6	127.0	105.6
9355	106.7	113.0	112.4	113.9	107.6
9292	100.0	99.7	92.8	118.3	97.8
955	104.9	104.5	139.2	144.0	104.3
9312	113.6	93.4	133.6	121.0	94.8
998	109.6	98.4	108.6	160.0	113.0
951	—	—	—	—	106.0
9264	—	—	—	—	104.2
9275	130.4	100.0	90.7	89.1	—
U.4/2	99.0	93.7	103.1	108.7	—
9331	98.4	95.2	95.6	104.3	—
9149	114.7	87.9	105.5	115.0	—
9232	101.7	98.5	110.2	128.0	—
913	105.2	94.7	87.7	107.1	—
H7	110.0	96.5	121.0	—	—
9241	89.6	116.5	94.6	—	—
9274	95.1	107.0	109.0	—	—
928	100.3	94.6	123.5	—	—
U.4 mean yield of lint per acre	338 lbs.	353 lbs.	293 lbs.	—	264 lbs.

The figures for the Nsoko test in 1931-32 are based on counts of green bolls made on each plot.

The five trials summarized in the above Table represent results obtained over a wide range of climatic conditions. With reference to the Nsoko trial of 1931-32, no clean cotton was reaped owing to the heavy infestation of stainer-carried bollrot. The plots had, however, made good even growth and it was felt that some method of yield comparison should be made. Counts of bolls which would normally have been expected to open were made on groups of plants in each plot. The figures obtained in this way were converted to comparable lint figures by applying the figures for boll weights and ginning percentages of the strains from previous years. It will be seen that practically all strains tested show increases in yield over U.4 bulk, while some strains have been consistently good yielders under all conditions. Strains such as 920, 9243, 9355 and 921 have always been successful, while the smaller and more early types, 998, 955, though successful at Bremersdorp, have shown to more advantage at the Ingwavuma and Nsoko stations. In addition to the actual tests, observation plots have been grown at a number of farms throughout the cotton area. These in the main have tended to confirm the results of the trials.

Spacing.—With the exception of the Bremersdorp results for the 1930-31 season no significant yield differences between the various spacings tried have been obtained. During the present season experiments were continued with an increased number of replicates to allow for loss of blocks through bad stands. The only trial which survived was that at Nsoko where a range of spacings from 12 inches to 36 inches was employed. The results showed no significant differences between any of the spacings. Apart from a watering before planting, the cotton was grown on rainfall only, and, with the early finish of the rains, the closer spacings went off badly. Early conditions were good and, with a little rain later in the season, the close spacings would have yielded considerably higher. The results from the 1930-31 season were given in full in the report for that year and these showed a significant increase in yield at Bremersdorp from close spacings of 9 inches and 12 inches over the wider spacings of 2 feet. The season was a good one and the close-planted cotton always appeared to have sufficient moisture. The experiment at Bremersdorp in the following year was on rather poorer soil and, though the close spacings again gave the highest yields, the differences were less marked.

The yields obtained from the spacings in the various trials are summarized in Table 2.

The experiments in 1930-31 and 1931-32 were planted in duplicate, using an early fruiting strain, A., and a later and more vigorous grower, B. Although the series of experiments has not been conclusive,

observation of the behaviour of the plants in the plots and in cotton fields, under a variety of conditions, indicate that a spacing of about 18 inches is most likely to be generally successful. Under conditions of low rainfall, especially where loss by bollworm has been considerable in the early part of the season, the moisture may be insufficient to allow the close spacings to set further crop. On the other hand, the wide spacings such as 30 inches or more are affected to a relatively higher degree through loss of plants from pests such as cutworms and beetle.

TABLE II.

Spacing.	Bremersdorp.				Ingwavuma.		Nsoko.
	1930-31.		1931-32.		1930-31.		1932-33.
	A.	B.	A.	B.	A.	B.	U.4 bulk
3½' by 9" ...	1,370	1,230	605	633	695	705	—
3½' by 12" ...	1,250	1,065	620	560	802	755	774
3½' by 18" ...	1,126	1,080	620	568	730	710	—
3½' by 24" ...	1,028	955	513	500	818	723	815
3½' by 30" ...	—	—	—	—	818	775	—
3½' by 36" ...	—	—	—	—	—	—	785

Thinning.—No experiments were carried out this season, and the results referred to were obtained in 1930-31 at Bremersdorp and Ingwavuma. Three stages of thinning were employed; 6 inches (normal), 9 inches (slightly delayed) and 15 inches (very late) and the experiment at Bremersdorp was duplicated at spacings of one foot and two feet. Table 3 gives the yields obtained in lbs. per acre of seed cotton.

TABLE III.

Height of Thinning.	Bremersdorp.		Ingwavuma, 2' spacing.
	1' spacing.	2' spacing.	
6" (normal)	910	664	628
9" (slightly late)	783	437	640
15" (very late)	702	270	446
Differences required for significance P. .05 ...	179	109	174

With the exception of the first thinning at Ingwavuma the yields show a progressive decrease with each delay in thinning and, further, the depression of yield due to delayed thinning is greater in the wider spacing.

Check-row Planting.—In the two previous seasons experiments were laid out at Bremersdorp to test the practicability of planting cotton in check rows so as to facilitate after-cultivation. The spacing employed was 3 feet by 3 feet which permits of adequate after-cultivation being done by ox- or mule-drawn cultivators. No definite yield comparison was obtained with the standard planting practice, and this season plots of the standard spacing were incorporated in the experiment as a control. Unfortunately, this shared the fate

of the other cotton on the station. The layout of the experiments included series of plots with 1, 2, and 3 plants per hole in 1930-31, and 1, 2, 3, and 4 plants per hole in 1931-32.

TABLE IV.

<i>No. of plants per hole.</i>								1930-31. <i>Yield per acre seed cotton : lbs.</i>	1931-32. <i>Yield per acre seed cotton : lbs.</i>
1 plant	...	...	...	...	...	...	...	912	721
2 plants	...	...	...	...	...	...	...	902	745
3 plants	...	...	...	...	...	...	...	1,008	726
4 plants	...	...	...	...	...	...	...	—	766

Though neither experiment showed significant differences in yield between any of the series, the practice of leaving more than one plant per hole is to some extent an insurance against loss of stand.

Fertilizer Effect.—Experiments were commenced in season 1930-31 to test the effect of applications of various fertilizers on cotton. The results in that year were inconclusive and further extended trials were planted this year. Owing to the sequence of storms the plots which survived were low and uneven in yield and afforded no reliable comparison. The previous year's figures are given below.

TABLE V.

<i>Treatment.</i>								<i>Yield of seed cotton per acre.</i>	
Superphosphate (250 lbs.)	...	...	...	...	...	...	...	1,540	lbs.
Bone Flour (150 lbs.)	...	...	...	...	...	...	...	1,581	"
Muriate of Potash (150 lbs.)	...	...	...	...	...	...	...	1,505	"
Unfertilized	...	...	...	...	...	...	...	1,469	"
Difference required for significance ($P=0.05$)								...	117

The experiment was planted on good soil and conditions for growth throughout the season were excellent. There was no significant yield difference between any of the treatments and, with the exception of the plots receiving potash, no differences in development were observed during the season. The series of plots with potash was somewhat later than the others, the flowering records showing a considerably lower flowering rate in the early part of the season.

Rotation Effect.—In 1930-31 it was decided to test the effect of previous cropping on the yields of cotton crops and a plot arrangement with randomized blocks was laid out. The crops and treatment included were maize, beans and groundnuts harvested in the usual manner ; sunnhemp and buckwheat ploughed under, and bare fallow. Cotton was planted over this area in the following year, 1931-32, and a similar experiment was conducted this year. The experiment in the present year was destroyed and the figures and notes below refer to

the previous season. The figures in Table 6 show the yield in lbs. seed cotton per acre and also the percentage of the crop in each of the three pickings.

TABLE VI.

<i>Treatment.</i>	<i>Yield per acre seed cotton</i>	<i>Percentage 1st picking.</i>	<i>Percentage 2nd picking.</i>	<i>Percentage 3rd picking.</i>
Fallow	1,565 lbs.	34.8	31.5	33.7
Buckwheat	1,526 "	39.2	30.0	30.8
Sunn hemp	1,335 "	53.5	19.6	26.9
Beans	1,320 "	52.2	22.0	25.8
Groundnuts	1,352 "	52.5	20.5	27.0
Maize... ..	1,425 "	50.0	22.3	27.7

Difference required for significance ($P=0.05$) 277

The experiment was planted on November 1st and conditions were satisfactory though the early part of the season was fairly dry. There were no significant differences in yield between any of the treatments, but the cotton after both fallow and buckwheat showed increases over the other treatments. The growth of cotton following maize, beans, groundnuts and sunnhemp was good throughout the season but cotton following fallow and buckwheat was very poor in the early stages. Growth continued to be slow until the ample rains in February, and, in addition, flowering was considerably later. In Table 6 the percentages of the crop picked at each of three pickings shows the delayed development. In a later section of the report, under maize, it will be seen that this same delayed development and poor early growth was observed in maize plots following bare fallow and a green manure crop of buckwheat.

ROTATION CROPS.

The profitable cultivation of rotation crops presents difficulties, apart from the purely agricultural aspect, owing to the relatively high cost of transport to the large towns for local consumption or to the ports for shipment. Cotton, with its comparatively high ratio of value to weight, has been able to bear this, but with crops such as cereals, oilseeds, etc., the cost of transport represents a substantial addition to the production costs. With the recent opening up of additional markets for good quality beef, and the erection of a Creamery in the Territory agricultural development is tending towards mixed farming. The necessity of supplementing the veld pasture will open up an alternative outlet for farm produce as cattle food.

Groundnuts.—This is one of the most generally successful crops in the country; good yields are being obtained and the crop is less subject to loss by insect pests and disease than the bean crops, while the "tops" provide a source of feed for cattle. Virginia Bunch has

been the variety generally grown locally, but seed of the higher yielding varieties tested on the stations has been distributed with satisfactory results.

The test of varieties was extended this season to include both a promising Indian type obtained from Barberton and a selection made locally, while a Virginia Bunch selection has been dropped on account of poor filling. The results of this season's trial at Bremersdorp are given in Table VII.

TABLE VII.

Variety.	Yields in lbs. per acre.		Shelling percentage.
	Unshelled nuts.	Kernels.	
Spanish	1,390	910	65.6
Japanese	1,315	825	62.7
Java	1,125	727	64.5
Virginia Bunch	1,315	815	61.8
Indian ex Barberton	1,470	950	64.5
Bremersdorp selection	1,885	1,200	63.5
Difference required for significance (P=05)	195	135	

Apart from the rather early close of the rains, the experiment had excellent conditions and under these conditions Spanish was again significantly higher in yield than Java, as also was the Indian variety, while the Bremersdorp selection was significantly higher than all others.

A summarized table of the performance of the several varieties in all trials is given below and also the average shelling percentages. The yields are expressed as percentages of the yield of Virginia Bunch.

TABLE VIII

Variety.	Yields as percentages of yield of Virginia Bunch.						Mean shelling percentage.	
	Bremersdorp 1930-31.	Ingvavuma 1930-31.	Nsoko 1930-31.	Bremersdorp 1931-32.	Nsoko 1931-32.	Bremersdorp 1932-33.	Bremersdorp.	Nsoko (Irrigated).
Spanish	139	129	110	233	250	106	58.2	59.1
Japanese	144	126	100	127	180	100	60.8	63.2
Virginia Bunch Selection	—	—	94.5	158	157	—	42.9	56.9
Java	—	—	—	104	156	86	66.1	66.9
Barberton	—	—	—	—	—	112	64.5	—
Bremersdorp	—	—	—	—	—	144	63.5	—
Virginia Bunch, actual yields... ..	696	1,080	1,384	456	865	1,315	60.5	64.4
No. of Plot Replicates	4	4	1	4	6	6	—	—

The Spanish variety has been consistently good throughout the series of tests both under rainfall conditions and under irrigation at Nsoko. In the season just concluded it again gave good results though the two new introductions, particularly the Bremersdorp selection,

outyielded it. The Virginia Bunch selection has been dropped as it is a poor filler except under conditions of high rainfall. All the above are bunch types and, with the exception of Virginia Bunch, bear small nuts. Further selections have been made and will be tested in the current year.

Description of varieties :—

Java.—A bunch type with a maturation period of approximately 140 days; the nuts are small, mainly two-seeded with light coloured kernels. This is reported to be the type in demand for the confectionery trade.

Spanish.—Also a bunch type similar in appearance and maturation period to the Java and is reported as suited to the same trade.

Barberton.—This resembles Spanish and is valued at the same price.

Virginia Bunch.—This variety is two to three weeks later in maturing than those mentioned above. The nuts are large but, except under good moisture conditions, a considerable amount of poor filling is found.

Japanese.—This is also a type with small nuts and a maturation period of 140 days, but the kernels are reddish in colour.

Bremersdorp.—A bunch selection with smallish nuts and light coloured kernels similar to Spanish. It differs in being slightly later in maturing and in its heavier foliage.

Fertilizer Effect.—The effect of applications of phosphates, at the rate of 200 lbs. Bone Flour per acre, was tested at Bremersdorp during the season. Part of the test was ruined by small buck and birds, but the three blocks which remained showed increases from the use of phosphate, the yields from this treatment being 1,000 lbs. per acre as against 730 lbs. from the unfertilized plots.

Observation plots receiving phosphate and lime gave similar increases with phosphate, but no differences from the lime application, the yields being :—

Bone Flour (200 lbs.)	...	...	...	1,150 lbs. nuts
Bone Flour (200 lbs.) plus lime (4,000 lbs.)	...	...	...	1,138 „ „
Lime (4,000 lbs.)	...	...	...	700 „ „
Unfertilized	...	...	...	750 „ „

Pests and Diseases.—The crop has been very free from pests and disease. Rosette has been observed, but in small amount and only in late planted crops.

Beans.—Except in some small areas where infestation by the large Cantharides beetle has been slight and rainfall well distributed, yields of grain have been low. On the Bremersdorp station the most successful have been Soya, Tepary and, to a lesser extent, Lima beans, while Sunnhemp, Velvet bean and Jack bean were promising as green manure crops. At Ingwavuma the cultivation of beans has been still less successful owing to the considerable losses from beetle attack and to the poor moisture conditions. During the winter months the plants

are much freer from beetle, and under irrigation at Nsoko very good yields of high quality have been grown in winter.

Fertilizer Effect.—Experiments during the season to test the effect of applications of phosphatic fertilizers on the yield of soya beans showed substantial increases where phosphate was applied.

Row Width Experiment.—Four plots of soya beans were planted, two at a row width of 2 feet 6 inches and two at 1 foot 3 inches the spacing in the rows being 4 inches in each case. The closer rows gave definite increases, the average yields for the two treatments being 1,415 lbs. per acre as against 1,110 lbs. Further experiments with a range of different beans will be planted with row widths ranging from 12 inches, as it is considered that density of population is important with the small grain types of beans. This method of planting requires that the land should be free from weeds, as after-cultivation is difficult. To overcome this to some extent, plots of beans were planted during the past season at the standard row width of 2 feet 6 inches and interplanted later after the crop had received a thorough cultivation. A dry spell followed the interplanting and no results were obtained.

Observation plots.—Plots of various beans—Tepary, Lima, Canadian Wonder, Speckled Sugar—and several varieties of Pigeon Pea, were grown. Tepary was again the most successful, yielding 1,200 lbs. per acre. Lima bean grew well, but lost much potential crop through the attacks of C.M.R. beetle. Canadian Wonder and Speckled Sugar were very unsatisfactory owing to damage by beetle and by a bacterial root disease.

The Pigeon Pea varieties gave good yields of grain and, as the plant remains green during the winter, it should be valuable as winter grazing in the low veld areas. This season it was observed that cattle ate the green shoots and pods greedily.

Maize.—With the exception of some few areas where the average rainfall is fairly high and the distribution satisfactory, the yields of maize are low. The varieties grown are almost entirely the late-maturing dent types, and in the areas of lesser rainfall it is considered that better results may be obtained with other varieties. With the object of studying their suitability to the general conditions, a wide range of types, 16 in number, was planted at Bremersdorp and Ingwavuma. The points under consideration were resistance to drought and disease and suitability for local consumption. The growth conditions at Bremersdorp were good, while at Ingwavuma the plots were not planted until early February and matured under severe conditions. The white and yellow flint varieties were the most successful, though a few of the white dents were sufficiently promising to warrant selection. Trials

of a few of the most promising types will be made in the current season.

Rotation Effect.—After the loss of the cotton in the storms of December maize was planted on the rotation layout. Growth conditions were good but, as with the cotton in the previous season, the early growth following bare fallow and a green manure crop of buckwheat was very slow, the maize plants showing up yellowish and unhealthy. Growth improved later to some extent, but was never so good as that of the maize following the other treatments. The experiment received no fertilizers and the yields were fairly good.

TABLE IX.

<i>Treatment.</i>	<i>Yield of grain per acre.</i>	<i>Shelling percentage mean of 4 samples.</i>
Fallow	1,560 lbs.	79.0
Buckwheat dug in	1,760 "	79.0
Maize—harvested	1,920 "	82.5
Beans—harvested	2,000 "	82.5
Groundnuts—harvested	2,060 "	84.0
Sunn hemp—dug in	2,020 "	83.0

Difference required for significance ($P = .05$) 338

The crop following fallow and buckwheat was considerably lower in yield than that following the other treatments, the cobs being smaller and the grain percentage lower.

Fertilizer Effect.—Observation plots of maize were planted on land which had received applications of phosphate and lime and substantial increases in yield were obtained from each treatment.

Spacing Experiment.—An experiment to test the effect of a number of spacings on the growth and yield of maize was conducted at Bremersdorp. The variety used was Hickory King, a white dent type generally grown in this area. The experiment received no fertilizer, but the rainfall was excellent and the crop had good conditions.

TABLE X.

<i>Spacing.</i>	<i>Yield of grain per acre.</i>	<i>Shelling percentage.</i>
6" × 3'	2,540 lbs.	82.0
12" × 3'	2,870 "	83.5
18" × 3'	2,430 "	84.0

Difference required for significance ($P = .05$) 321

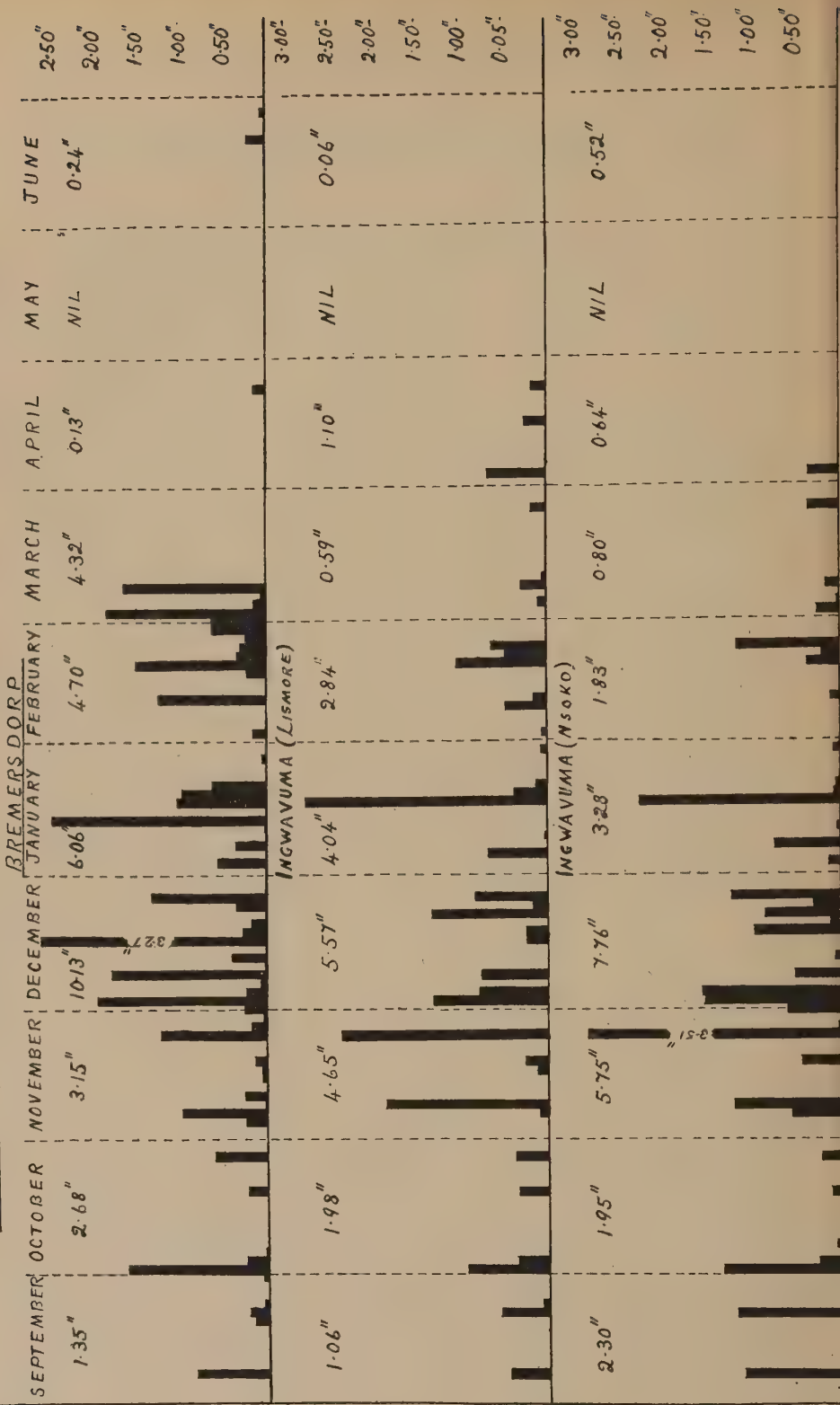
Under the favourable conditions of this season, the 12-inch spacing easily outyielded the others—the closest spacing contained a proportion of sterile plants and in general showed signs of overcrowding. Under the drier conditions at Ingwavuma, observation plots indicate the suitability of a wider spacing—2 feet—between plants in the row.

Kaffir corn.—The crop is grown almost entirely by natives and the work carried out has been along the lines of selection of types from the very mixed seed grown at present. A number of fairly uniform strains

has now been obtained and the more promising of these will be tested against the ordinary bulk in the coming season, for yield comparison and suitability to local conditions.

Native Agriculture.—During the past few years interest has been shown by natives in the cultivation of cotton and in the improvement of their existing methods of cultivation of food crops. This season plots of cotton were planted at a number of suitable centres in order to instruct the natives in the method of planting, thinning and the general handling of the crop. These were worked by the natives themselves and the necessary instruction given by trained natives employed by the Corporation. In addition, three natives in the area planted on their own account. The plots aroused considerable interest in the district and already some two dozen natives have applied for seed for planting in the current season. The land chosen for instruction plots was on the whole poor and characteristic of the worn-out lands in the native areas, while, in addition, planting was late and rainfall not very favourable. Yields were low, averaging about 400 lbs. seed cotton per acre, but in spite of this, the financial returns were regarded very favourably. The value of the crop to the native will be considerable as, apart from the welcome money return, it will introduce a system of crop rotation. The crops grown at present are Kaffir corn and maize and, to a lesser extent, a variety of legumes. The result is that the cropping is almost continuous cereal-growing until the field is worn out. In addition to instruction in the growing of cotton, efforts are being directed towards improving the general system of cultivation.

RAINFALL (Two Day Totals) SWAZILAND — SEASON 1932-1933.



SOUTHERN RHODESIA

REPORT ON THE WORK OF THE COTTON - BREEDING STATION, GATOOMA, FOR THE SEASON 1932-33.

INTRODUCTORY NOTE BY G. S. CAMERON.

The Summary of Results, 1932-33, from the Gatooma Station is a synopsis of the work performed throughout the year. It follows more or less the same lines as in previous years with slight modifications and improvement in the technique involved.

Further knowledge has been gained of American bollworm in such aspects as the attacks on other host plants throughout the year, the stage of the crop at which it is attractive to the moths for egg-laying, and the relative attractiveness of crops to the moths.

The season, contrary to that of the previous year, is best described as being "lop-sided"—too much rain at the beginning, and not enough later on. Under such conditions, the strain, spacing, and other trials are of little account, but it has to be emphasised that it is in such seasons that a vigorous cutting-out of less desirable selections can take place. No new re-selections were made, and only seven main lots remain to be further multiplied.

Jassid was fairly severe. Stainers throughout the country did very little damage in comparison with former years: wild host plants are being located.

Thanks to the funds voted by the Corporation, it is now possible to keep in closer touch with observation and record plots in the districts. For the same reason, it will henceforth be possible to undertake much more detailed investigations into the habits of insect pests, particularly bollworms.

While the acreage planted to cotton last year was disappointingly small owing to the low prices ruling round about planting time, it is gratifying to know that there will be a slight increase in acreage in the ensuing season. This is due to the continued low price of maize, combined, possibly, with a reduction in ginning charges. Although cotton has scarcely secured more than a foothold in the agricultural economy of the Colony, it is slowly dawning upon farmers and others that it has held on by virtue of its own merits, unassisted by bounties, controls and other subsidy measures.

Many who formerly were opposed to the idea of cotton being grown by natives, have now come round to the opinion that anything which the natives can grow and sell on the world's market is to the benefit of the country. Such being the case, it is possible that a Native cotton-growing industry may become established, to their own benefit and that of the European farmers in the Colony. There are indications that this promising line of expansion is about to materialise, but it will be a slow process in the initial stages.

COTTON-BREEDING STATION, GATOOMA ; REPORT FOR THE SEASON 1932-33.

SUMMARY OF RESULTS

BY

J. E. PEAT.

During the period under review the staff has been the same as in the previous season, Messrs. A. H. McKinstry, A. N. Prentice, and the writer, of the Empire Cotton Growing Corporation, Mr. A. G. H. Rattray and Mr. J. Z. Boshoff. Mr. Prentice was on leave from mid-March until the end of September.

SEASON.

On the Station planting rains were slightly later than usual. (Fig. 1.) A dry spell occurring in December delayed the germination of part of the later planted portion of the crop, which thus did not actually get away properly until the end of December. The rainfall was then heavy until the end of January, but much of this heavy fall was ineffective, and indeed a check to the growing crop. Rain ceased toward the end of February.

The total rainfall of 29.54 inches does not convey a true picture of the season, which was one of drought with a very short growing period. The first planted crop was moderate to poor, while the last planted portion of the crop did not do well. The plant response varied according to the quality of the land. In other areas where the rains were more evenly distributed, some quite fair crops were reaped.

STRAINS AND TRIALS.

Owing to the season, the results from the strain, spacing, and other trials, have not been of much account.

It has been, however, quite a valuable year for sorting out strains in the breeding and multiplication plots. A hard season such as the past, with a fair jassid attack, is useful in sifting out the more valuable

from the less valuable material, in showing up the weaknesses, and in assessing the values of the strains retained.

A considerable amount of discarding has been done. Excluding the three strains at the big bulk stage, U.4/64 (Gatooma No. 5), U.4/64/7/10 (Gatooma No. 5, 11) and U.4/64/V (Gatooma No. 5, 21), only seven main lots remain for further multiplication on the Station, and testing, in small observation plots, with growers throughout the country. There are, in addition, a number of minor strains still under general observation. No new re-selections were taken. There remain forty-eight observation lots from last season's single-plant lines, derived chiefly from the three families /34, /64, and /78.

Much of the commercial seed of the country is now U.4/64. Again this past season it has shown that it is the best of the basic strains of U.4 bred out at Gatooma. Hardy and fairly prolific, it has stood up well to a fair range of conditions.

U.4/64/7/10 and U.4/64/V, both substrains of /64, were the two strains issued to growers for multiplication and for observation this past season. Both are being grown again this coming season throughout the country. 64/7/10, nearly a fortnight earlier than 64/V, was the more striking both on the Station and with growers in other districts. This was to be expected in a dry, short growing season. 64/V has the very important quality for Rhodesia of producing lint of better character under more difficult climatic and soil conditions. There are some very promising re-selections from it.

U.4/64/1/2 (Gatooma No. 5, 24) is another free-fruited /64 strain. While heavy fruited and fairly early, it still maintains moderately good jassid resistance.

U.4/26/B/2 (Gatooma No. 2, 26) is markedly the earliest of the strains at the bulk stage: small-bolled, prolific, and free-fruited, only moderate for jassid resistance, its earliness is pronounced, but it is not a strain for hard conditions and does not have the powers of recovery of some of the others.

Two substrains of U.4/34/2/1 (Gatooma No. 4, 2), U.4/34/2/1/2 (Gatooma No. 4, 5) and U.4/34/2/1/3 (Gatooma No. 4, 6), while maintaining the high degree of jassid resistance of the family, are freer fruited and earlier. With the high degree of jassid resistance they possess, they are most important strains.

U.4/78/3/5/2 (Gatooma No. 6, 16) is an improved substrain of U.4/78/3/5 (Gatooma No. 6, 7). Like the parent it is a valuable strain with relatively big bolls, good quality lint, fairly good jassid resistance, and gins out distinctly better than the /64 derivatives, but probably requires better conditions for good results.

SPACING.

The further experience of the year supports the general ideas expressed about spacing in this country. For most conditions a fairly close spacing of about 6 to 12 inches in the row appears to be giving the best results. Spacing closer than about 6 inches, generally the result of careless or neglected thinning, tended this past season to give a forced, spindly type of growth and resulted in a weak crop. This was especially noticeable on good land. A use of wider spacings will probably be wise on the richer types of land.

RESPONSE TO SOIL CONDITIONS.

This year, with the short, droughty season, it was noticeable that the better crops reaped were those growing on better land, land in fair heart. On poor and worn out lands, crops were poor. They were unable to produce plants with a framework sufficient to carry a crop. On better soils, in good heart, the crops pulled through more happily.

CROP DEVELOPMENT.

The routine recording of growth, flowering, bolting and shedding, was continued and the attempted analyses of the losses due to climatic conditions and bollworm attack. Comparable, though more simple records were taken by native recorders on farms in the districts. It was a season, taking the country as a whole, where the loss caused by bollworm was of lesser importance than the loss caused by the drought. Not only was there the shedding loss, directly attributable to the drought, but in addition, there was the greater loss, caused by the stunting of the crop and the inability of the plants to put on a fresh crop.

INSECT PESTS.

Jassid.—On the Station the jassid attack was fairly severe, heavy enough to cause serious distress to the more susceptible varieties, and sufficient to be of value in assessing the resistance of strains. There appeared to be less jassid damage in the crops in the districts. The relatively high degree of jassid resistance possessed by the /34 family is of importance. The newer strains combine with this resistance, fairly early maturity and a freer fruiting habit than the parent stock.

American Bollworm (*Heliothis obsoleta*).—More detailed recording of the pest than in other years has been attempted during the season. A further extension of the recording programme, and in greater detail, will be made in the ensuing year. The American bollworm infestation

on the Station was relatively small, although heavier on the Station than on the farms in the districts where records were taken, and probably heavier than on most of the farms visited. (Fig. 3.)

The experiments which have been going on at Gatooma, in collaboration with Parsons, in the use of *Trichogramma lutea* as an egg parasite have not been productive. But an interesting point that has emerged is that the Rhodesian strain or strains of *Trichogramma lutea* appear to be considerably more virile than the Barberton strains used in the parasite release experiments. Quite high percentages of natural parasitism have been obtained from collections of American bollworm eggs from cotton and maize, both from the Station, and from farms in Mazoe and Lomagundi, as contrasted with the low natural parasitism around Barberton.

The important results from the more intensive study of American bollworm egg-laying have been the recording of the time and duration of egg-laying on crops other than cotton, and the appreciation that this egg-laying took place over an attractive period for each crop, speaking generally, over the immediate pre-flowering and flowering periods. These results support Parsons' important findings.

The detailed records taken during the *Trichogramma* release experiments showed the attractive period for maize to be over the period of tassel extrusion. (Fig. 4.)

The recording of egg-laying on maize and on beans on the Station, showed their potentialities as trap crops. Before American bollworm egg-laying started on cotton there was considerable egg-laying on beans at the bud and early flower stage and, later, on maize just coming into tassel, at that time apparently more attractive to the egg-laying moths than cotton. At the other end of the season, in April, there was heavy American egg-laying on annual bean lands just coming into flower, at a time when egg-laying had ceased on cotton nearby. These findings may have important practical application in the effective use of maize and possibly other crops, as trap crops, keeping the American egg-laying off cotton at the critical period for the making of the crop.

In ordinary farm practice, in most of the cotton areas, the bulk maize is planted over a period of three weeks to a month, and, probably, from past observation, it is only when the attraction for the moths, provided by the tasselling of the main maize crop, has ceased, that egg-laying increases seriously on cotton. By the use of late-planted trap crops of maize it may be possible to prevent to a considerable extent the American egg-laying on the cotton crop. During this coming season detailed recording in cotton and the traps will be undertaken.

FIG. 3.

BOLLWORMS
SEASONAL DISTRIBUTION
TWICE-WEEKLY COUNTS

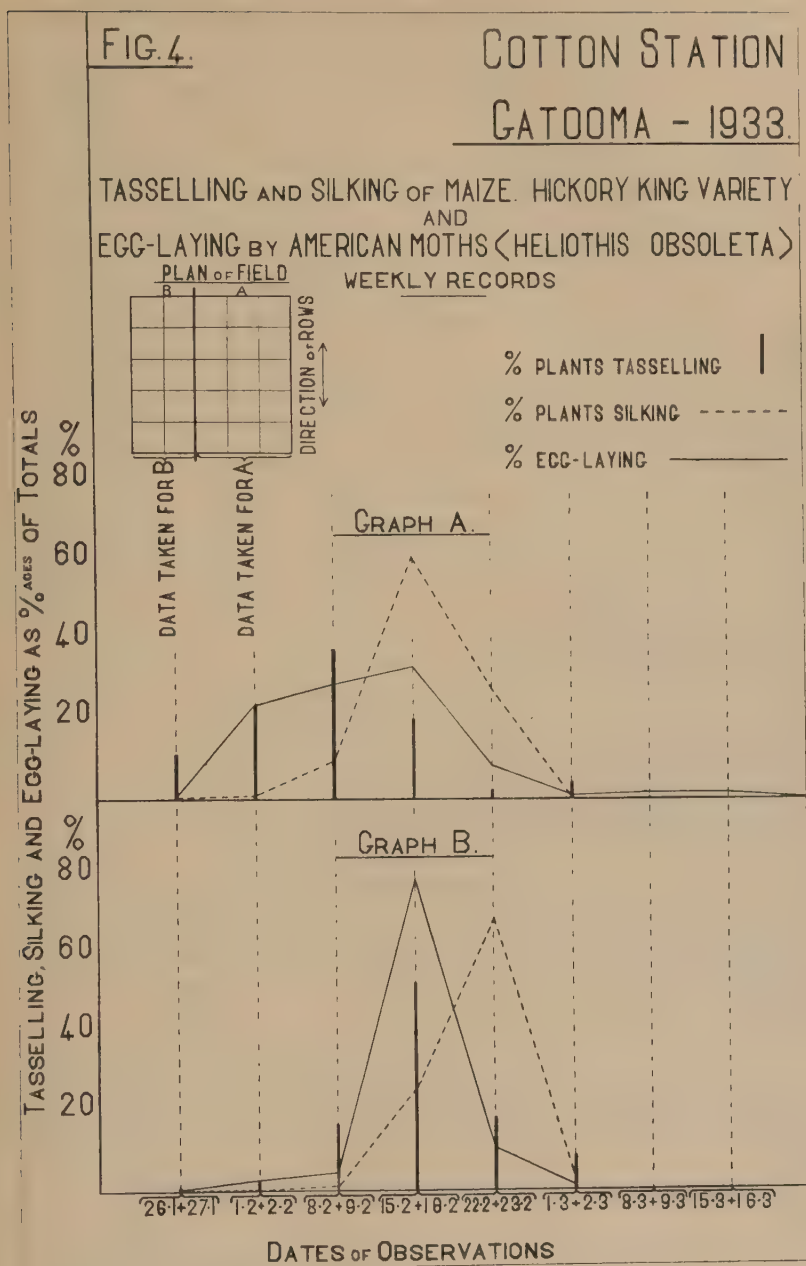
BOLLWORMS PER 100 PLANTS

COTTON STATION
GATOOOMA - 1933.

— AMERICAN BOLL WORM
- - - SUDAN BOLL WORM
..... SPINY BOLL WORM

JAN. FEB. MAR. APR. MAY. JUN. JUL.





NOTE.—A block of 25 acres was marked out for *Trichogramma* release experiments. The scanty planting rains caused irregular germination, and thus irregular tasselling in the first planted area, A, Graph A. Note duration of egg-laying and the relation of egg-laying to tasselling. Compare with Graph B.

In the B portion of the field, germination was regular, and tasselling more uniform.

In a preliminary recording of egg-laying, on the Mazoe Citrus Estate of the British South Africa Company, the egg-laying on citrus was noted to be related to the flowering stage of the trees. Records on winter crops showed egg-laying on wheat at the stage when it was just coming into ear, and on oats at a similar stage. The Estate is to test out the use of maize as a trap-crop for the American bollworm egg-laying, which occurs to a greater or lesser extent each year in the groves, around the latter part of August and in early September.

Sudan or Red Bollworm (*Diparopsis castanea*).—Again this season on the Station the attack of Sudan bollworm was considerable, heavier than on the other farms where records were taken, and heavier probably than in most of the other areas visited. The attack was continuous in form. (Fig. 3.) Experiments in the use of standover cotton traps are being continued.

Stainers.—The stainer attack was light throughout the country, mainly *D. intermedius* and *D. fasciatus*. As a result it was not possible to record, as had been intended, the efficacy or otherwise of the practice of cotton-seed trapping in relation to the stainer population present in the lands at the time.

Areas of wild host plants, *Sterculia*, *Thespesia*, and Baobabs, are being located, and preliminary information gathered about stainer infestation on them, preparatory to some recording of stainer species movements in cotton and the natural host plants.

DISTRICT RECORDING.

In future it will be possible to employ a better type of native recorder, recruited from the Government Native School at Dombashawa, for recording work in the districts, and for the more detailed recording work on the Station. This side of the work is of increasing importance in a country such as Southern Rhodesia, with its wide range of conditions.

The staff of native recorders should be of considerable value later on for recording work in the scattered native areas, many of which will be more or less difficult of ready and frequent access to the technical staff.

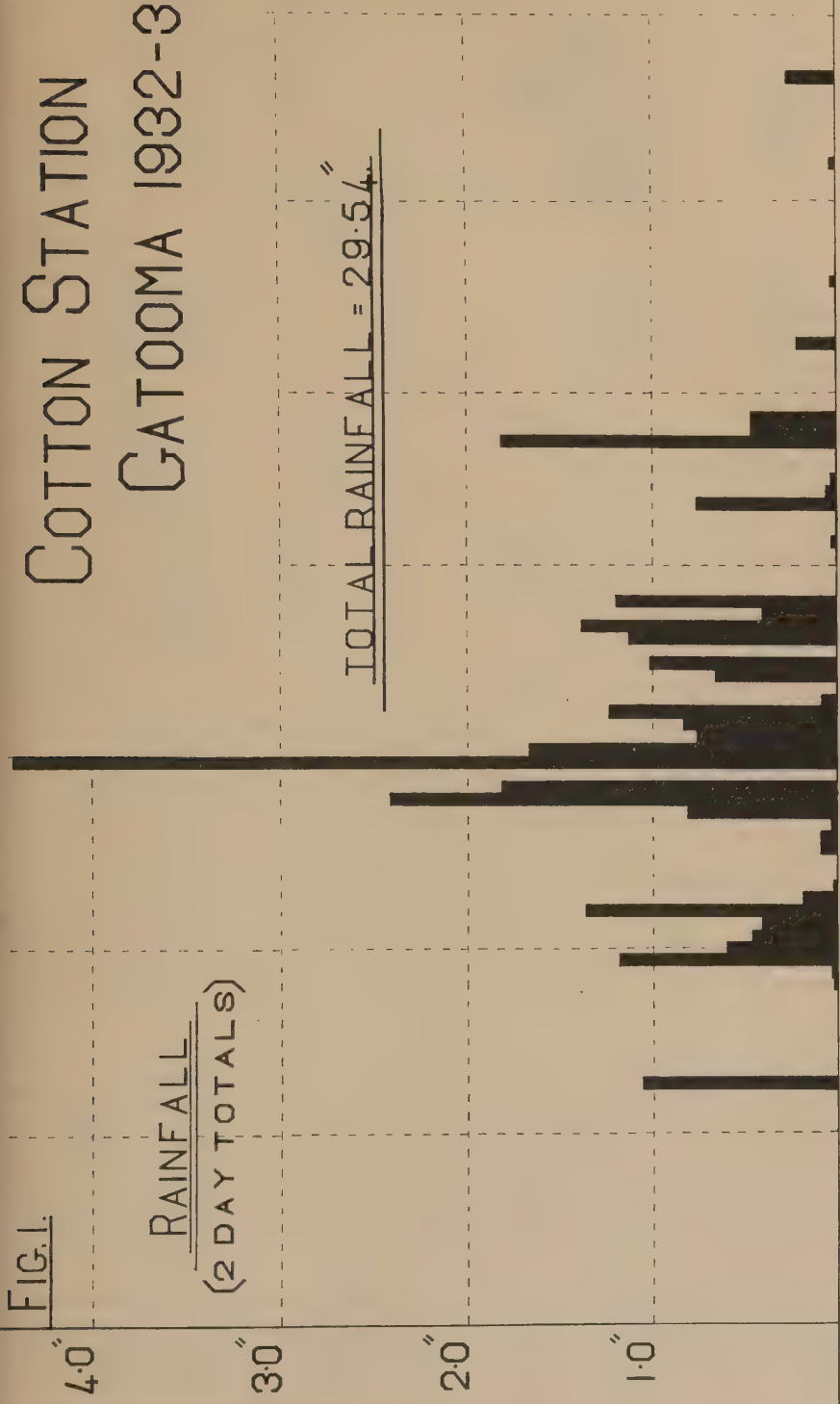
FIG. 1.

COTTON STATION

GATOOMA 1932-33.

RAINFALL
(2 DAY TOTALS)

TOTAL RAINFALL = 29.54"

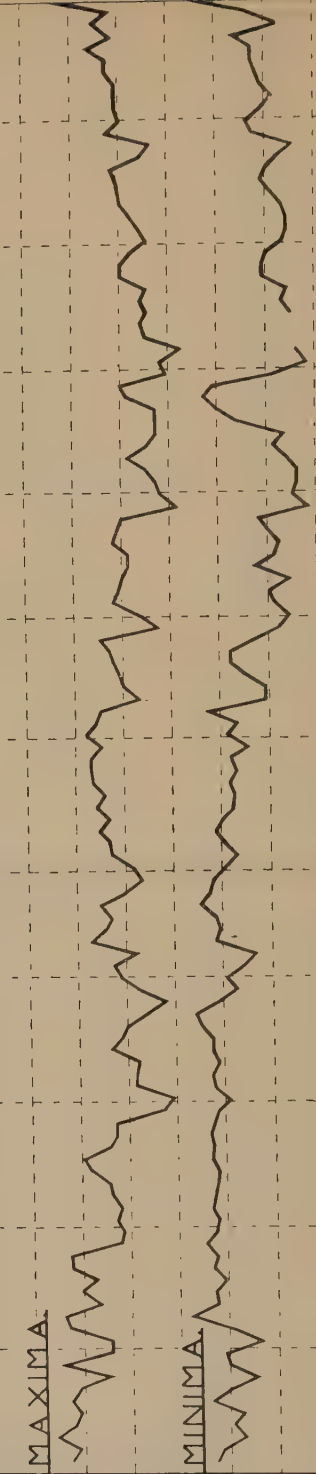
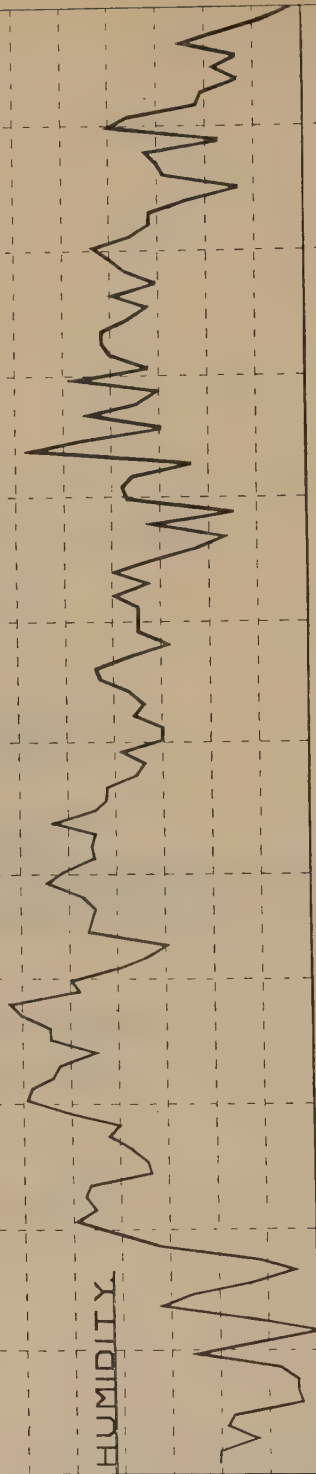


OCT. 0 " NOV. 26 " DEC. 12 " JAN. 10 " FEB. 3 " MAR. 25 " APR. 30 "

HUMIDITY AND TEMPERATURES COTTON STATION

(3 DAY MEANS) FIG. 2.

GATOOA 1932-33.



OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUN. JUL. AUG. SEP.

NORTHERN RHODESIA.
REPORT OF THE WORK ON COTTON AT THE
RESEARCH STATION, MAZABUKA,
1932-33.

SUMMARY OF RESULTS

BY

A. G. BEBBINGTON (*Empire Cotton Growing Corporation*) AND W. ALLAN
 (*Northern Rhodesia Department of Agriculture*).

SEASON.

Ploughing rains were late and planting did not start until the end of the second week in December. The rains throughout the season were very uneven, there being long periods of dry weather followed by periods of very heavy rain. No rain fell after the end of February and in consequence the crop set by the plants was very much smaller than in the two previous seasons. This smaller crop was largely offset by the fact that losses due to Stainer were much less than in former years.

Flying swarms of the red locust (*Nomadacris septemfasciata*) were active during May, June and July, the Station being visited by ten swarms during this period. Crops were successfully defended by smoke screens, and the use of flags and tins.

Jassid did not appear in any numbers during the season. Bollworm appeared in quite large numbers in March and April. Stainer (*Dysdercus*) attack was severe during March, but owing to the disappearance of *D. supersticiosus* in early April and the very late appearance of *D. fasciatus*, a large proportion of the crop escaped serious damage.

STAINERS.

Seasonal distribution counts were continued as in previous seasons and in addition a count was made on a bulk crop at a neighbouring farm. The figures from the latter count were completely vitiated from May onwards owing to the defoliation and damage to the plants caused by locusts. Up to that point, however, the figures obtained from the two counts were in complete agreement.

The early influx of *D. supersticiosus* occurred as usual and was comparable in extent with figures obtained for previous seasons. *D. fasciatus*, on the other hand, did not appear on cotton until the

latter part of June by which time two pickings had been taken. *D. intermedius* appeared in very small numbers only.

A study of the fluctuation of *Dysdercus* population on *Thespesia rogersii* was continued. The distribution of *D. supersticiosus* on this host was similar to that of previous seasons, the species appearing in large numbers at the time of flowering. The fluctuations in the *D. fasciatus* population were very unusual. In other seasons there has been a very marked decrease in the population during March and April, coincident with the appearance of the species on cotton. In the present season the *Thespesia* population did not decrease during these months, and infested trees could be found within a few yards of uninfested cotton. Towards the end of May and in June there was a decrease in the population. Records of fruiting and flowering of *Thespesia* which have been kept appear to offer a ready explanation of this distribution.

The observations of the present season have confirmed the view that *Thespesia* is the most important wild host of *Dysdercus* in this area. Records have been made from time to time on Baobab, but mainly during the dry season. Only *D. fasciatus* has been recorded on this host. Various species of *Sterculia* have proved to be host plants in the Union of South Africa and Southern Rhodesia. Two species, *S. triphaca* and *S. quinqueloba* have been identified in Northern Rhodesia, but so far *Dysdercus* has not been found on them, even when closely adjacent *Thespesia* was carrying a large population. It is thought that *Sterculia* may be suitable as a host only for a short period of the year.

The Ecological Survey has provided considerable information on the distribution of these host plants in North Western Rhodesia, and arrangements have been made for plots of cotton to be grown at various distances from areas where they are known to occur.

An estimation of the difference in stainer damage on two types of soil where variation had previously been observed was repeated. An estimate of the amount of damage, both as shedding and as lint discolouration, was made by tagging all squares on samples of plants of four strains of cotton on both types of soil. The method of ascertaining damage was that used in previous seasons. In addition, a count of the stainer population on three strains of cotton was made for both types of soil.

Differences in stainer population were found corresponding to the variation in the amount of final damage, the population on the larger plants growing on the heavier soil being considerably greater than that borne by the smaller plants on the lighter type of soil.

There was no difference in the stainer population shown by counts made in the early morning and during the afternoon, the figures generally indicating that there is very little movement about the field.

Chemical data, particularly with reference to nitrate production, were obtained for both soil types at intervals during the season. The results yielded no further information to explain the behaviour of the plants, beyond the differences in carbon and nitrogen previously observed.

The curve representing the distribution of stainer damage throughout the season resembled those obtained in previous years in that *D. supersticiosus* again caused severe damage to the early crop, but owing to the very late appearance of *D. fasciatus* much of the later crop was undamaged.

BOLLWORM.

The distribution of, and the extent of loss caused by, *Chloridea obsoleta* was similar to that recorded in previous years.

VARIETY TRIAL.

A trial of six strains of U.4 laid out in a randomised block with eight replications was carried out in conjunction with work on Stainer and the soil differences observed in previous seasons. Stainer counts on three strains showed that U.4/6, a vigorous bushy plant was more attractive to Stainer than 921, a small habit type. The final yields showed that U.4/2 and U.4/4 were significantly better than bulk.

TIME OF PLANTING.

A modified experiment with three plantings each replicated four times again showed that early planting is to be recommended.

SPACING EXPERIMENT.

A trial of three spacings laid out as a randomised block with six replications failed to give significant results, owing to very great soil variations and insufficient replications. A census of Stainer damage was undertaken in order to ascertain whether the damage in closer spacings was greater than in the wider spacings, but no significant difference was obtained.

SINGLE PLANTS.

Eighteen single plants carried forward from the previous season were planted. These were mainly of the small habit type which it is thought will assist in the solution of the stainer problem. All have been kept and a small bulk of one will be tested in a strain trial in the coming season.

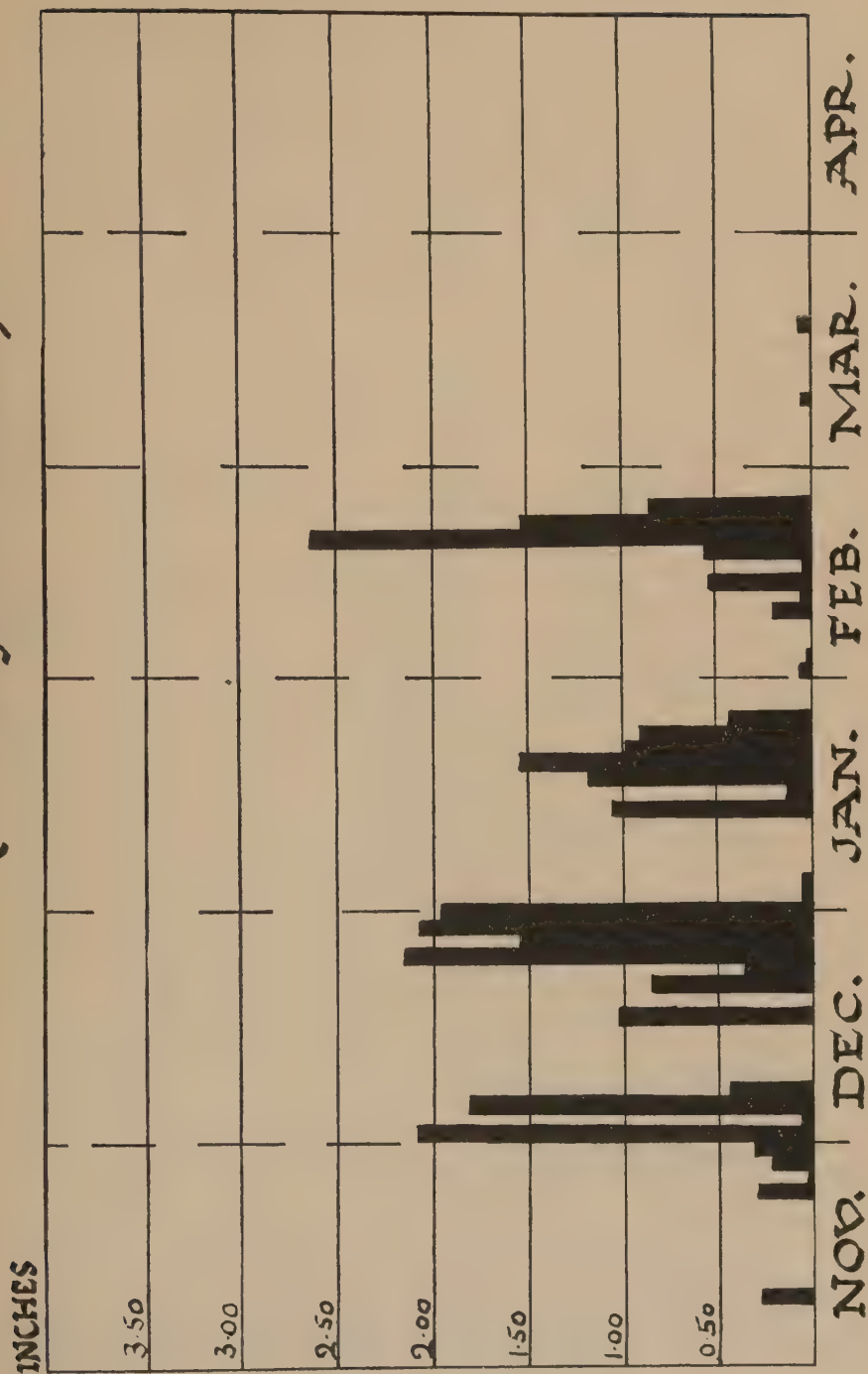
DAILY RAINFALL—SEASON 1932-1933.

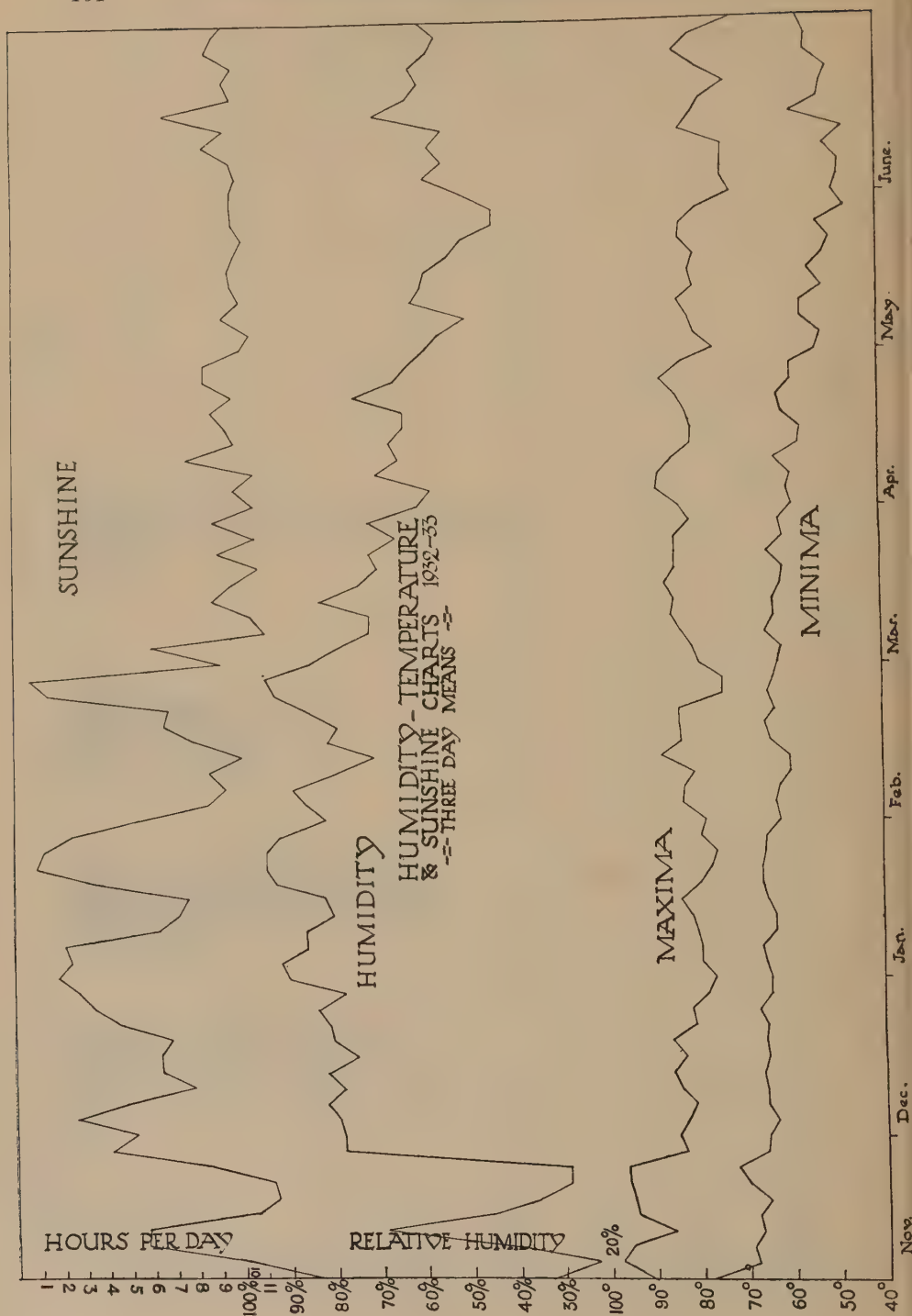
	<i>Nov.</i>	<i>Dec.</i>	<i>Jan.</i>	<i>Feb.</i>	<i>Mar.</i>
1.	—	0.60	1.21	0.07	—
2.	—	1.49	0.01	—	—
3.	—	0.07	0.01	—	—
4.	—	—	—	—	—
5.	Tr.	1.80	0.02	0.02	—
6.	—	—	—	—	—
7.	—	—	—	—	—
8.	—	0.42	—	—	—
9.	0.15	—	—	—	—
10.	0.14	—	—	—	0.02
11.	—	—	—	—	—
12.	—	—	—	0.20	—
13.	—	—	—	—	—
14.	—	—	0.44	0.05	—
15.	—	—	0.64	—	—
16.	—	—	—	0.53	—
17.	—	0.64	0.22	—	—
18.	—	0.37	0.82	0.04	—
19.	—	—	0.36	0.23	0.07
20.	—	—	1.30	0.36	—
21.	—	0.66	0.24	0.89	—
22.	—	0.16	0.65	1.72	—
23.	—	—	0.34	0.94	—
24.	0.30	0.36	0.91	0.57	—
25.	—	1.25	—	0.83	—
26.	0.03	0.91	0.45	—	—
27.	—	1.01	—	—	—
28.	0.23	0.51	—	—	—
29.	0.21	0.58	—	—	—
30.	0.11	1.50	—	—	—
31.	—	0.74	—	—	—
	1.17	13.07	7.62	6.45	0.09

Total for Season, 28.40 inches.

No rain recorded in the remaining months.

RAINFALL MAZBABUKA 1932-1933 (2-DAY TOTALS)





ANGLO-EGYPTIAN SUDAN

REPORT ON THE WORK ON COTTON CARRIED OUT AT SHAMBAT BY THE PLANT BREEDING SECTION, GEZIRA AGRICULTURAL RESEARCH SERVICE, SEASON 1932-33

SUMMARY OF RESULTS.

BY
TREVOR TROUGHT.

INTRODUCTION.

The cotton grown in the Sudan is either Egyptian Sakel or American in type. At present the more important type is the Egyptian type, grown in the Gezira, in Kassala and in Tokar.

As heretofore, work on Egyptian types (with which are included Sea Island and related types) aims at producing, primarily, a cotton which will prove better suited to the peculiar conditions which prevail in the Gezira.

These conditions are, briefly, the result of combinations of climatic factors with soil factors, together with the irregular incidence of diseases, notably Blackarm (*B. malvacearum*) and leaf-curl. These give rise to disconcerting fluctuations in yield from year to year. In years when the combination is favourable, excellent yields may be obtained, but there is no assurance of this with the present type of Egyptian Sakel.

A cotton which would fulfil the main requirements aimed at for the Gezira should (1) give consistently good yields from year to year, (2) be resistant to Blackarm and leaf-curl, and (3) have a similar quality of lint to Sakel lint (the saleability or tenderability of the cotton under present contracts being thus unaffected).

With respect to the Gash Delta (Kassala) and Tokar areas, the assumption is made that a cotton which is an improvement in the Gezira, would also be an improvement in Kassala and Tokar. When the main problem of the Gezira approaches solution, more attention can be paid to the particular problems of these areas. It is not certain that the assumption made is more than partially correct, and a type quite unsuited to the Gezira might prove better suited to Tokar or Kassala.

Turning to the problems of American types of cotton, it will be recalled that a type known as " Pump Scheme Strain " has been grown successfully for some years both on irrigated areas North of Khartoum, and in rain-fed areas in the Nuba Mountains and Mongalla.

The lint of this strain is popular with brokers, and in replicated comparative trials its yields have easily held their own with new varieties or types.

To obtain a cotton which will outclass Pump Scheme Strain over a series of seasons has proved difficult, but work is still being directed to this end.

EXPERIMENTAL.

Egyptian (and Sea Island) types.

The work can be classified under the following main headings :—

- (a) Pedigree Line Breeding and Hybridisation.
 - (b) Comparative varietal testing (which includes comparative observations on disease resistance).
 - (c) Valuation and Spinning Tests.
 - (d) Propagation.
- (a) *Pedigree Line Breeding and Hybridisation.*

An elastic routine on recognised lines deals with the progenies of single plants selected either from the commercial crop or from the previous year's single plant progenies. A number of types showed up well in 1932-33 and have been retained for further testing. The majority of these were selections from new types which have reached the bulk propagation stage, but which have not yet been cultivated on a large scale.

Special attention was paid to a search for types resistant to Blackarm (*B. malvacearum*), in co-operation with the Government Botanist. Thousands of seedlings have been sprayed with a suspension of the bacterium, including Sea Island $\times$ *G. tomentosum* hybrids sent by Dr. Harland. Only two plants were found which showed some apparent resistance to the disease and both these plants were killed by stemborer during the hot weather, without producing seed.

As Shambat lies some 35 miles north of the most northerly portion of the Gezira area, a feature of this work is the testing, in "parallel cultures," at the Gezira Research Farm, of these progenies grown at Shambat. The growth of the types under Gezira conditions is carefully noted and compared, and these records are of great assistance in making selections for further trial.

(b) *Comparative Varietal Testing.*

The experimental work under this heading was carried out at Shambat, at the Sudan Plantations Syndicate's Seed Farm at Barakat, and at the Gezira Research Farm, Wad Medani. At the latter place, the experiments were conducted jointly by the Plant Breeding Section and the Plant Observation Section of the Gezira Agricultural Research Service.

A list of the experiments, with short notes and the tabulated yield results (where applicable) will be found in Appendix A. In these experiments the variety used as the "control" for comparative purposes is the ordinary main crop Sakel grown throughout the Gezira.

As a result of previous years' observations two types known as X.1530 (a selection from the Sakel main crop), and X.H.1229 (a fixed hybrid between Sakel and Sea Island cotton) had reached in this year the final stage of propagation under the Plant Breeding Section's Control, and were in competition as to which should be recommended for further propagation. Both these types, in addition to a satisfactory yield performance in previous years, had shown a high degree of resistance to leaf-curl. This resistance was maintained last season in all the tests.

The year was not a good one for Sakel (the average yield for the Gezira was almost exactly 2 large kantars* of seed cotton per feddan*). This fact makes the behaviour of X.1530 all the more remarkable.

In all the tests X.1530 showed an outstanding superiority in yield and averaged an increase of 106% over main crop Sakel. X.H.1229 failed to approach this standard, though it gave somewhat higher yields than the control in certain of the comparisons.

The Comparative Inspection Plots showed that X.1530 was able to retain this superiority in different parts of the Gezira, but that X.H.1229 was probably definitely unsuited to the Northern area. Thanks are due to the Manager, Sudan Plantations Syndicate, and the Manager, Kassala Cotton Company, for permission to put down these plots.

Shambur IV, a variety which has been tried in previous years, failed to show a real superiority over the main crop. In view of the difficulty in picking which is experienced in this variety, it will be discarded.

At Shambat, types which had not reached the stage of propagation of the above varieties were tested in the Preliminary Varietal test. The yield of the control main crop type was good here ($4\frac{1}{2}$ large kantars of seed cotton per feddan). The two varieties, X.04729 and X.730, showed 13% and 22% increase of *lint* per feddan over the control. Confirmation of this result was obtained in the Gezira in the "Microchequer" experiment, though on account of a severe white ant attack the yield figures in this experiment are not so reliable.

Other varieties however, in this experiment, showed also such superiority to the control that the differences could scarcely be

*1 large kantar = 315 rotls.
 1 small kantar = 100 rotls.
 1 rotl. = 1 lb. (approx.).
 1 feddan = 1 acre (approx.).

accidental. These included, in addition to the two just mentioned, X.1730 (a type similar to X.1530, possibly a slightly better yielder, but not so resistant to leaf-curl) and Lecrem (a selection made by Mr. A. R. Lambert from leaf-curl resistant plants in a plot of "Massey's Domains Sakel").

Of new varieties which are still in the earliest stages of selection, X.1030 C and X.1530 A gave over 50% increases over the control in the "Line Test." X.1030 C is a selection from X.1030 ("Bolland's Sakel") but differs in type of habit, while X.1530 A is a selection from X.1530 for improved lint quality and yield.

(c) *Valuations and Spinning Tests.*

A number of samples from experimental plots were valued and graded through the courtesy of Mr. Charles Wolstenholme, of Messrs. Wolstenholme & Holland.

Spinning Tests on Egyptian types of cotton were carried out by the Experimental Department of the Fine Cotton Spinners' and Doublers' Association, to whom thanks are due.

From the graders' and spinners' reports X.04729 appeared to be a useful and desirable type. X.1530—the type referred to earlier as having such excellent agricultural qualities—proved to be fully equal to the Main Crop Sakel.

An interesting point in connection with the spinning tests was the sharply defined locality effect. All the four types grown at Shambat spun better than any type grown elsewhere. The Shambat crop was a good crop, whereas the Gezira crop was not good. In this case yield and spinning quality have gone together.

(d) *Propagation.*

Five types were propagated in bulk.

- (i) Shambur IV. Ninety feddans were grown through the courtesy of the Sudan Plantations Syndicate at the Barakat Seed Farm.
- (ii) X.1530. Fifteen feddans were grown at Shambat (including $2\frac{1}{2}$ feddans from self-bred seed).
- (iii) X.H.1229. Fifteen feddans were grown at Shambat.
- (iv) X.1030. Two feddans were grown at Shambat.
- (v) X.H.830. Two feddans were grown at Shambat (including half a feddan from self-bred seed).

Propagation and testing occur simultaneously; in this way, when a variety under test proves satisfactory, time is saved in introducing it on a commercial scale.

General Summary of Results of Tests on New Cottons.

During the season under review, the capability of the type X.1530 to give good yields in an unfavourable season was the most striking

feature of the work. Its resistance to leaf-curl, its high ginning outturn, and ability to compete with Sakel on equal terms in spinning tests (characteristics noted in previous seasons) were maintained.

It was decided that the propagation of X.1530 should be continued on as large an area as the available seed would allow, with a view to its replacement of the Egyptian Sakel type over the whole area.

Two other types, X.04729 and X.730, showed considerable promise and further tests and propagation will be carried out on these types.

The decision noted above radically alters the basis of the breeding work of the section; though X.1530 is a decided advance, it still falls short of ideal—it is not, for example, resistant to Blackarm; and probably both yield and lint quality can be improved. Attention also can be given now to the problems of Kassala and Tokar, while future developments in the trade bringing a demand for a different lint type can be considered.

Work on American Types of Cotton.

(a) Pedigree Line Breeding and Hybridisation.

Single plant progenies of those families which showed promise were grown at Shambat, with parallel cultures in the Nuba Mountains (Kordofan) and Mongalla Province.

A strain ("514") derived from Pump Scheme Strain and one ("513") derived from an introduction from India, were outstanding for vigour and high yield, together with resistance to leaf-curl, and work on these types will be continued.

Families derived from Parnell's U.4 were grown, and selections for better staple made.

Types from Uganda do not do well at Shambat, though they succeed in the South. Selections among the Uganda types were made for trial under rain-grown conditions.

The majority of the families selected for parallel culture under rain-grown conditions showed satisfactory growth in the South.

At Shambat there was a much more severe attack of leaf-curl on the American types than usual. Also a plant with leaf-curl was found in the American crop at Nuri (a pump scheme in Dongola Province). This is believed to be the first occasion on which leaf-curl has been definitely reported on cotton at a northern pump station.

In consequence of the possibility of leaf-curl spreading to the American crop, a number of families which proved particularly susceptible to this disease were discarded. Eleven F_3 families from a cross Pedigree Dixie $\times$ Lone Star were grown. Further selections were made to try and fix a long-stapled type with a high ginning outturn.

Nine lots of seed received from Dr. Harland were grown, and a number of single plant selections were made.

(b) *Comparative Varietal Testing.*

A list of the experiments with their tabulated yields (where applicable) is given in Appendix B.

In the Line Test at Shambat a change was made in the "control" type. For technical reasons Pump Scheme Strain has not been used as control in this experiment, Delrect II serving this purpose in previous years. As evidence had been accumulating that a type known as X.A.1129 (derived from an unknown hybrid found in a plot of Meade) was particularly promising, this type was used as control. The control proved superior in lint yield to all types tested except Pump Scheme Strain and the two strains which were specially remarked on in the Pedigree Lines (*vide supra*).

Nuba Mountains.

In the Varietal Tests in the Nuba Mountains a statistical examination of the results showed that in the Talodi A experiment the differences between Pump Scheme Strain and X.A.1129 were insignificant, but that these two varieties were significantly better than the remaining three. The differences between these three were insignificant.

In the Talodi B experiment, X.A.129 (a selection from Pump Scheme Strain) was significantly better than the Pump Scheme Strain control, but not than X.A.2030 (a selection from Columbia). Two other selections from Columbia (X.A.2728 and X.A.2829) were significantly worse than the other three types.

At Kadugli there was no significant difference between the types.

Taking brokers' valuation and ginning outturn into consideration, X.A.1129 gave the best cash returns in the Talodi A and Kadugli tests, and X.A.2030 in the Talodi B test (which did not include X.A.1129).

X.A.2829, when personally inspected at Talodi, did not appear satisfactory in growth and has been discarded. Mr. Ducker has since reported that this type is very susceptible to jassid in Nyasaland.

Mongalla.

In Mongalla Province, a Uganda type, S.G.29, replaced X.A.2030 in the tests, and proved to be significantly better than all the other varieties except Pump Scheme, at both localities. Taking into account the brokers' lint valuation and the ginning outturn, Uganda S.G.29 also gave the greatest cash return per feddan. X.A.1129 did not seem so well suited to conditions in this area.

(c) *Valuation and Spinning Tests.*

The grading and valuation were done by Messrs. Wolstenholme and Holland, and the spinning tests by the British Cotton Industry Research Association, to whom our best thanks are due.

On the basis of valuations of Pump Scheme Strain, cottons grown under irrigation at Shambat had better lint than Nuba Mountains cottons, and these were, in turn, better than Kirrippi (Mongalla) cottons. The Columbia derivatives (X.A.02629, X.A.2529, X.A.2030) obtained the best valuations in the Nuba mountains, but X.A.1129 was better in Mongalla.

The spinning test results were very similar to last year's tests and were summarised as follows :—

“ X.A.1129, X.A.02629, and X.A.129, gave the strongest yarns in thelea tests, of these X.A.129 gave a comparatively low work of rupture both in 40's and 50's, and is therefore not so good with respect to strength as the other two strains. In appearance, however, X.A.129 gave good yarns, X.A.1129 being fairly good and X.A.02629 fair in this respect. On the whole there is little to choose between these three strains, and all are worth further study.

“ X.A.2030 is the least satisfactory sample, being weakest and amongst the poorest in appearance. S.G.29 gave yarns of fairly good appearance, but not equal to those of Pump Scheme Strain either in appearance or in strength.”

(d) *Propagation.*

X.A.1129 and X.A.02629 were grown on 15-feddan plots at Bouga.

At Shendi three small propagation plots were grown, including a plot of X.A.129.

Owing to the severe Pink bollworm and Egyptian bollworm attacks at these places, the yields were considerably reduced.

General Summary of Results of Tests on New Cottons.

The variety X.A.1129 again maintained a high level of performance in both yield and spinning tests. Further propagation of this type in the Nuba Mountains will be arranged for by the Inspector of Agriculture at Kadugli on an area of 80 feddans, on the land of two reliable cultivators. At Talodi a number of local cultivators selected by the Inspector of Agriculture at Talodi will try the type on small areas.

A cotton of the Uganda type seems the most promising for Mongalla, but the replacement of Pump Scheme Strain by Uganda S.G.29 cannot be wholly recommended yet. Further work with selections made from the Uganda S.G.85 type seems hopeful.

The two types known as 513 and 514 have given such promising results in the preliminary tests that multiplication of these to allow of extended larger scale tests is being expedited.

Miscellaneous Experiments at Shambat Research Farm.

A number of other experiments were undertaken.

These included the usual "Observation Plot" experiment in which regular records are made. This collection of data on growth and development serves for comparison with similar data collected in previous years. Early growth this year was slightly more rapid than in the previous year, but node production was less.

In observations made on the incidence of leaf-curl attack, a correlation between the blight of the plant and increased leaf-curl attack was noted.

The "Shade Experiment" was repeated on an expanded scale. Last season, a small plot of American cotton grown under permanent light shade was compared with an unshaded plot. This year a deeper intensity of shade was used in addition to the light shade.

Last year, under light shade, yield was reduced 50%. Shading increased the height and number of nodes produced, reduced bud and flower production, but also reduced leaf, bud and boll shedding.

These results were confirmed, and under the deeper shade, bud production was still further reduced, and flowering completely suppressed.

Experiments on the value of "Indore" compost as a manure for cotton, and a comparison of different methods of sowing gave inconclusive results.

APPENDIX A.

List of Experiments carried out under the Head of Comparative Varietal Testing of Egyptian Types.

- (1) *Line Test at Shambat.*
- (2) *Inspection lines at the Gezira Research Farm.*

These two tests are parallel, the same varieties being tested in each locality. Strains about which further information is required, and new strains from promising families are included and tested against main crop Sakel. Lines of the variety are grown between control lines, in triplets, and the stand in each line of each triplet is "equalised." Flower counts and yields are recorded.

- (3) *Preliminary Varietal Test at Shambat.*

This is a replicated strip test, on a field scale, arranged in randomised blocks with five repetitions. It includes new varieties which have reached a further stage of propagation.

The results are tabulated below :—

TABLE I.
PRELIMINARY VARIETAL TEST (SHAMBAT RESEARCH FARM).

Variety.	Seed-cotton in big Kantars per feddan.	Lint in small Kantars per feddan.	G.O.T. %
X.730	4.94	4.76	30.6
X.H.830	4.69	4.45	30.1
X.1030	4.62	4.15	28.5
X.04729	5.20	4.40	26.9
Gezira Main Crop	4.31	3.91	28.8
X.H.730 (Belts)	2.61	2.31	28.1

(4) *Microchequer Experiment at the Gezira Research Farm.*

This included all the varieties tested in the preliminary Varietal Test, and three others in addition.

Each variety was replicated three times and the layout was such that each variety plotlet was the centre of a group of four similar "equalised" plotlets of main crop Sakel.

Great losses occurred in the field from white ants, so that yield figures are subject to considerable error, and are not published.

(5) *Standard Variety Test, Barakat Seed Farm.*

This is a test on a field scale of types still further advanced in propagation.

There were five strips of each variety, arranged in randomised blocks.

The results are tabulated below :—

TABLE II.
STANDARD VARIETY TEST (BARAKAT SEED FARM).

Variety.	Seed-cotton in big Kantars per feddan.	Lint in small Kantars per feddan.	G.O.T. %
X.1530	3.51	3.32	30.0
X.H.1229	1.37	1.11	25.7
X.H.1029	1.56	1.45	29.4
Shambur IV	1.52	1.23	26.6
Gezira Main Crop	1.56	1.37	27.7
X.730 (Belt)	2.03	1.94	30.2
X.04729 (Belt)	2.10	1.78	26.9

(6) *"Three Factor" Experiment, Gezira Research Farm.*

In this experiment the new types which were tested at Barakat were tested under different conditions of manuring and sowing date.

There were four repetitions of each combination, which gives eight repetitions of each variety at each sowing date, and 16 comparisons in all.

Although manuring is not practised in the Gezira, the inclusion of a manurial treatment not only tests the reaction of the different varieties to manuring, but also extends the applicability of the results in relation to the Gezira as a whole, as the tests are made on what is equivalent to two types of soil—one with less and one with greater fertility.

The results are tabulated below :—

TABLE III.
"THREE FACTOR" EXPERIMENT (GEZIRA RESEARCH FARM).
(Yields in big Kantars per feddan.)

Variety.	1st Sowing.		2nd Sowing.	
	Without N.	With N.	Without N.	With N.
	Seed-cotton.	Seed-cotton.	Seed-cotton.	Seed-cotton.
X.1530	2.76	4.66	2.91	4.49
X.H.1229	1.83	2.93	1.16	2.13
X.H.1029	1.93	2.92	1.51	2.32
Shambur IV	1.83	2.55	1.21	2.10
Gezira Main Crop	1.56	2.39	1.38	2.00
X.1730 (S. Belt)	2.19		2.32	
X.1030 (N. Belt)	2.51		1.88	

The increases in X.1530 with manure are so high that, if confirmed in subsequent years, it would seem that the application of Ammonium Sulphate to a general crop of X.1530 would be a "paying proposition."

The fact that X.1530 and X.1730 (a similar type) did not show in the second sowings that drop in yield which other varieties showed, is noteworthy.

(7) Comparative Inspection Plots.

Single $\frac{1}{20}$ feddan strips of X.1530 and X.H.1229 were grown between similar strips of main crop Sakel. The plots were sited, by courtesy of the Manager, Sudan Plantations Syndicate, and the Manager, Kassala, in the north, central and southern Gezira, and in the west on the Kassala Cotton Company's area.

(8) Inspection Plots.

Small plots of Ishan and certain new types were grown at the Gezira Research Farm for observation.

Note.—The experiments at the Gezira Research Farm were carried out in co-operation with the Plant Observation Section, Gezira Agricultural Research Service.

APPENDIX B.

List of Experiments carried out under the head of Comparative Varietal Testing of American Types.(i) *Line Test at Shambat.*

The layout is the same as for the Egyptian Line Test (Appendix A). The control variety was X.A.1129.

(ii) *Standard Variety Tests, Nuba Mountains and Mongalla Province.*

Three experiments were carried out in the Nuba Mountains, two at Talodi and one at Kadugli.

Two experiments were in Mongalla Province, one at Opari and one at Kirripi. The layout of all these experiments was similar. The test is on a field scale, with five replicated strips arranged in balanced randomised blocks, to allow of statistical examination of the results.

The results are tabulated below :—

TABLE I.
TALODI "A."

Variety.	Seed-cotton in large Kantars per feddan.	Lint in small Kantars per feddan.	G.O.T. %
X.A.2829	3.43	3.05	28.2
Pump Scheme Strain	3.66	3.46	30.0
X.A.02629	3.36	3.20	30.2
X.A.1129	3.59	3.48	30.8
X.A.2529	3.33	2.95	28.1
X.A.2730 (Belts)	3.46	3.03	27.7

TABLE II.
TALODI "B."

Variety.	Seed-cotton in large Kantars per feddan.	Lint in small Kantars per feddan.	G.O.T. %
X.A.2829	3.86	3.44	28.3
Pump Scheme Strain	4.09	4.05	31.4
X.A.2728	4.02	3.66	28.9
X.A.2030	4.26	4.13	30.8
X.A.129	4.39	4.39	31.7
X.A.2730 (Belts)	3.43	3.00	27.8

TABLE III.
KADUGLI.

Variety.	Seed-cotton in big Kantars per feddan.	Lint in small Kantars per feddan.	G.O.T. %
X.A.2829	3.34	2.93	27.9
Pump Scheme Strain	3.09	2.85	29.3
X.A.02629	3.13	2.96	30.0
X.A.1129	3.33	3.19	30.3
X.A.2529	3.09	2.73	28.1
X.A.2730 (Belts)	2.08	2.57	26.4

TABLE IV.

KIRIPPI.

<i>Variety.</i>	<i>Seed-cotton in large Kantars per feddan.</i>	<i>Lint in small Kantars per feddan.</i>	<i>G.O.T. %</i>
X.A.2829	2.74	2.25	26.0
X.A.02629	2.46	2.18	28.2
Pump Scheme Strain	2.80	2.37	26.9
Uganda S.G.29	2.94	2.50	27.0
X.A.1129	2.44	2.12	27.6
X.A.2030 (Belts)	2.77	2.41	27.6

TABLE V.

OPARI.

<i>Variety.</i>	<i>Seed-cotton in big Kantars per feddan.</i>	<i>Lint in small Kantars per feddan.</i>	<i>G.O.T. %</i>
X.A.2829	1.55	1.22	25.0
X.A.02629	1.47	1.26	27.0
Pump Scheme Strain	1.90	1.61	26.8
Uganda S.G.29	2.09	1.72	26.2
X.A.1129	1.50	1.27	26.8
Parnell's U.4 (Belts)	1.71	1.57	29.0

(Included by courtesy of the Uganda Government.)

UGANDA

REPORT OF THE COTTON BREEDING SECTION DEPARTMENT OF AGRICULTURE SEASON 1932-33

SUMMARY OF RESULTS.

BY

G. W. NYE AND H. R. HOSKING.

BUKALASA ZONE.

Meteorological Conditions.

Abnormal weather was experienced throughout the season—the planting period being very dry and the early period of harvesting in January unusually wet. The sum total of the abnormalities eventually reacted in favour of the crop and satisfactory yields were obtained.

Breeding Plot.

(a) *New Selections.*—The most promising among these were families of B.31, the strain most resistant to Blackarm. B.37 and several U.4 derivatives did quite well.

(b) *Pedigree Lines.*—The best of these was a U.4.4.2 derivative (B.P. 38/32) which gave a high yield and was highly resistant to Blackarm. A re-selection from S.G.23/8—B.P.44/32—also showed considerable promise.

Variety Trial.

Eight varieties were included, S.G.23/8 being the most satisfactory. B.P.21/31 (a U.4 derivative) was unsatisfactory. It would appear that, generally speaking, U.4 is not particularly suited to Buganda conditions although some selections appear to possess better lint characters than U.4 and U.4.4.2.

District Variety Trials.

The most striking results were the average yields, which were in every case over 900 lbs. per acre. No differences between Local and S.G.23/8 were obtained, but S.G.29 gave lower yields in nearly every case.

Interchange of Seed Experiment.

The final results show no difference to be obtained by growing a variety out of its environment for a season. On the other hand, certain environmental effects on germination and Angular Leaf Spot were observed.

Spinning Tests.

S.G.23/8 was again outstandingly superior in spinning qualities to all other varieties.

Insect Pests.

The most serious pest at Bukalasa was *Helopeltis bergrothi* especially on early sown cotton. This pest also did considerable damage to cotton in Northern Bulemezi and Buruli where soil conditions and weather are not so favourable as in other parts of Buganda. *Lygus* was present, but did not do such severe damage as in previous seasons.

Disease.

Blackarm was present in the usual quantity, and observations were carried on. Several resistant strains have been isolated and are being fully tried out.

An unidentified wilt disease appeared to be more prevalent than in past years.

General.

The Local cotton gave further evidence of the need for new seed and every effort is being made to obtain a suitable strain for distribution as soon as possible.

The general grade of the Buganda crop was to some extent affected by rain in January and the staple appeared to be shorter than usual.

SERERE ZONE.

Meteorological Conditions and Diseases.

Unfavourable weather conditions were experienced. Rainfall was irregular except in May and September. During the latter month the precipitation was excessive and this combined with hail brought on a severe attack of Angular Leaf Spot. Fortunately the following two months of October and November were dry and this successfully checked Blackarm disease.

Jassids were considerably less than in the two previous seasons.

Helopeltis bergrothi.—Serere was free from this pest, although it caused considerable damage in certain parts of the area east of the Nile, notably in Central Bugwere, Eastern Busoga, South Budama and South Bugishu.

Lygus vosseleri.—This insect was again much in evidence and appears to have caused a considerable reduction in yield at Serere.

Serere Variety Trial.

Eight varieties were included in the Serere Variety Trial. U.4 and

SP.1 (the latter is a re-selection from Parnell's U.4.4.2) were outstanding. No real difference could be shown between N.17 and S.G.29.

Variety Trials in the Districts.

Ten similar 4×4 Latin Squares were planted at centres scattered over the area east of the Nile. Two of these centres gave no result. From the remaining eight trials, a combined analysis of variance showed SP.1 to be superior to the other three varieties (*i.e.*, N.17, S.G.29 and SP.4), but failed to show any real difference between N.17 and S.G.29.

Quarter-Acre Comparisons of S.G.29 and N.17.

To summarise the results, it was found that N.17 gave a significantly better yield than S.G.29 in the Bugwere, Budama and Bugishu group, but in the remainder of the Zone, S.G.29 gave the better yield.

The Breeding Plot.—In the Pedigree Lines, all the strains originating from S.G.29 and S.G.27 were abandoned owing to marked susceptibility to Blackarm. The U.4.4.2 re-selections and the Nariama group (originating from S.G.129) were again the most successful, particularly in respect to their comparative resistance to Blackarm attack. Of the New Introductions, those from India and Nyasaland were failures, but several promising plants were selected from some Southern Rhodesian U.4 derivatives.

Seed Multiplication.

The Serere Main Farm gave a very poor crop of S.G.29. As a result, the land is to be abandoned and new areas opened up. These areas will be run on a system of two years' cropping followed by four years' of "bush fallow." Ordinary rotations with lavish green manure courses have failed dismally.

A new scheme of seed multiplication and distribution was introduced. S.G.29 was grown in three segregated areas of 400, 4,000 and 25,000 acres each. The average yield over the whole 29,000 acres amounted to 293 lbs. of seed cotton per acre.

The districts of Bugwere and Bugishu will receive the seed grown in the 25,000-acre stage for the 1933/34 season.

General.

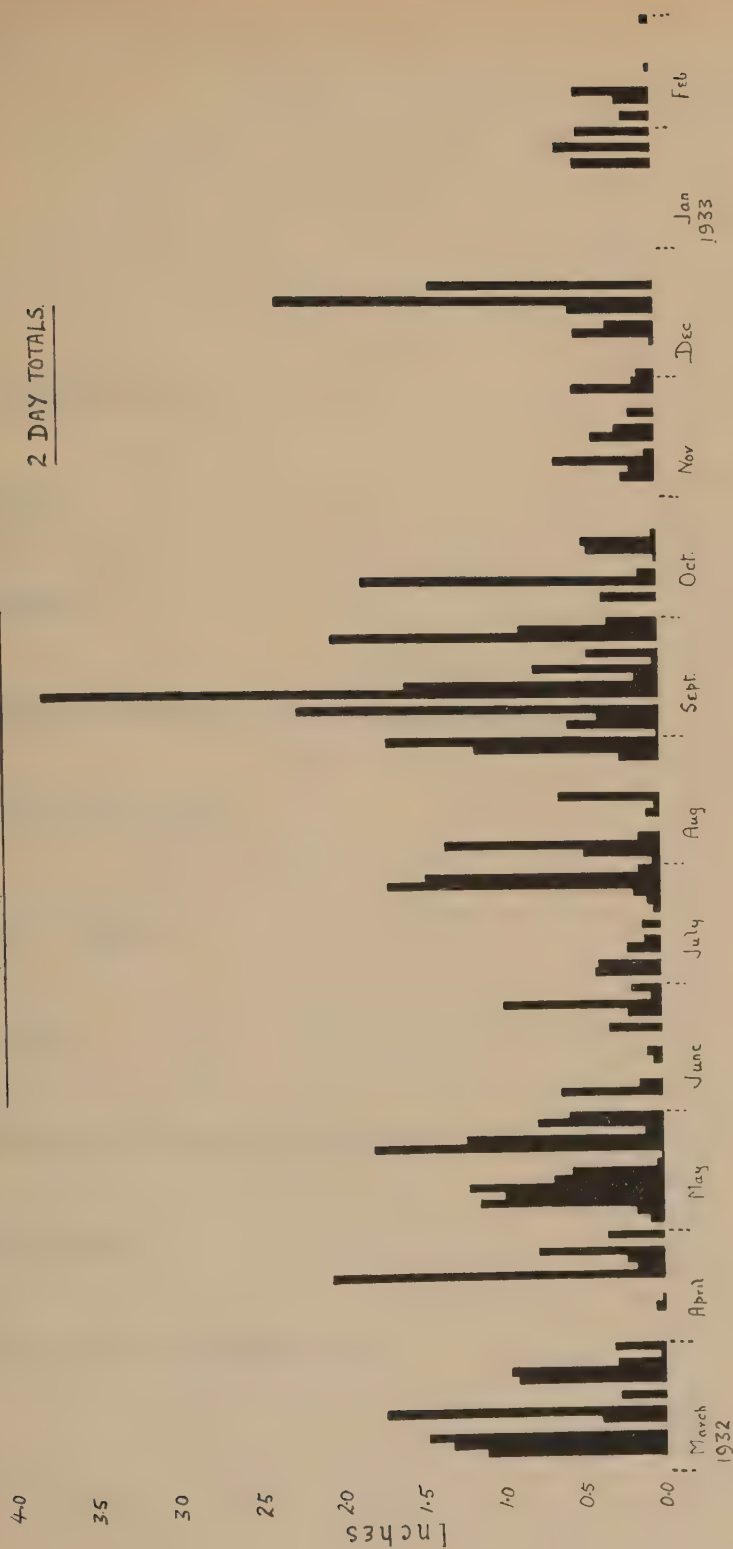
Although Uganda produced its record crop, Teso district gave a low yield per acre. Lango and Busoga districts had a particularly successful season.

During the cotton buying season an attempt was made to improve the grade of the purchases by prosecuting those buyers who were accepting low grade cotton. Numerous convictions were obtained, and it is hoped that this will have the desired effect in future seasons.

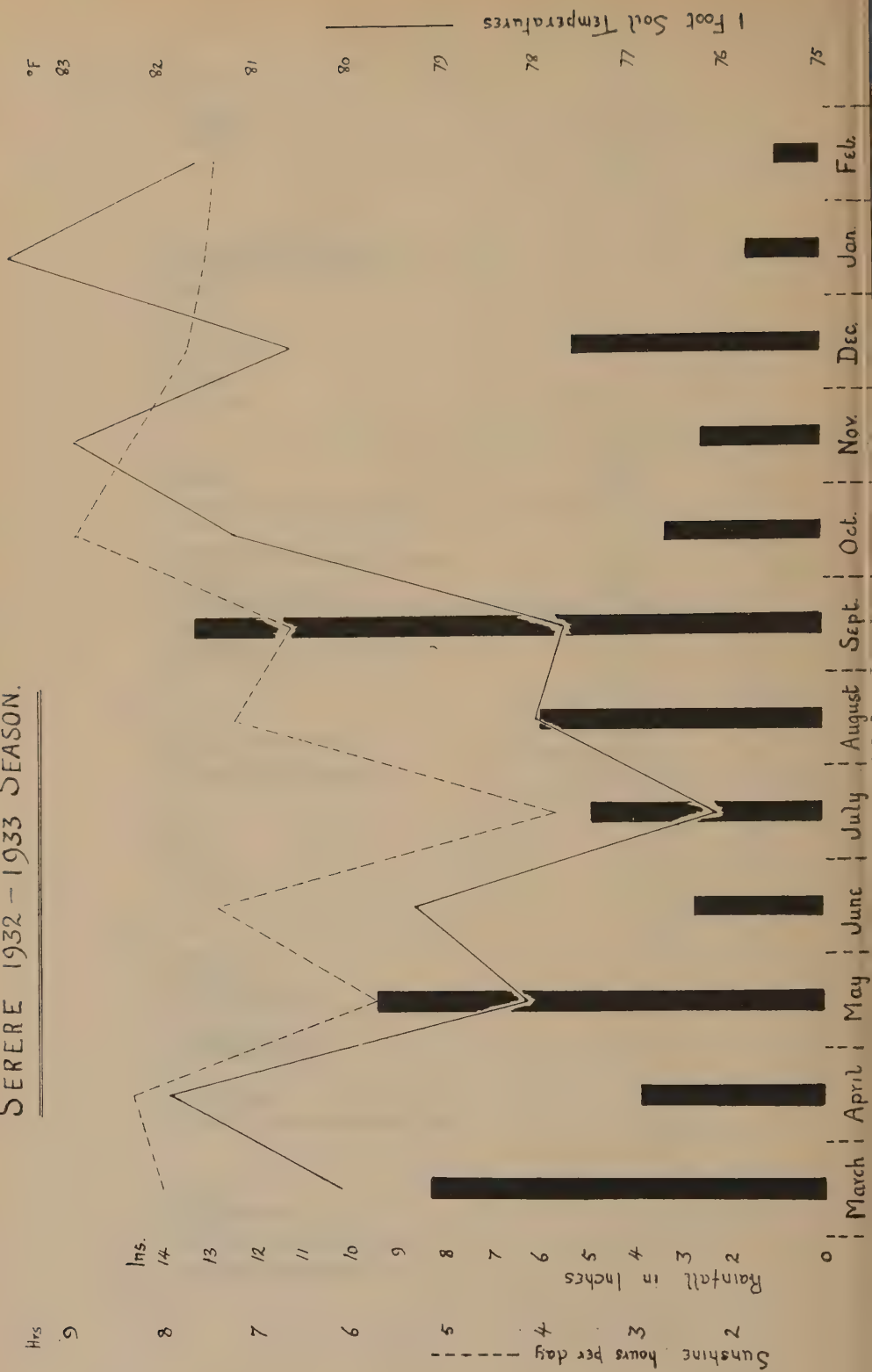
RAINFALL 1932-33
 BUKALASA
 (TWO DAY TOTALS)



SERERE - 1932/33 RAINFALL



SERERE 1932 - 1933 SEASON.



NYASALAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATIONS, SEASON 1932-33.

SUMMARY OF RESULTS.

GENERAL NOTE

BY

H. C. DUCKER.

Concentration at Domira Bay of the cotton experimental work under the direct control of the Corporation in Nyasaland is virtually complete.

A total of 150 acres of land actually under cultivation is now cleared at this station, and from 1933 onwards the five-course rotation as described in the report last year will be in operation. This rotation provides for the annual cultivation of 60 acres of cotton, an area which it is believed will prove adequate for the work in hand. New works have been commenced to provide the necessary accommodation at Domira Bay, and a programme of building has been planned for completion this coming season which, it is thought, will satisfy needs for some years to come.

The past season has confirmed the opinions given in previous reports as to the suitability of the Domira Bay area for cotton. The average yield of 250 lbs. lint per acre over the entire acreage at the Station speaks for itself.

The south-western Lake shore belt appears to possess particularly safe rainfall conditions, which should enable the cotton breeding programme to be carried on in a most satisfactory manner.

Makwapala has had its last season as a cotton station, and, though the cotton yields this past season were particularly good, there has been no evidence to show that previous opinions regarding its unsuitability for cotton breeding work are in error. As is usual, the proportion of stained cotton was far higher at this station than at Domira Bay.

Port Herald, now a Government District Station, suffered from a badly distributed rainfall, which was again on the low side for the sandy alluvial soil of this station. It was also somewhat badly afflicted by locusts.

At Lilongwe a satisfactory mass selection plot was grown at the Likuni Station. Some fifty single-plant selections, which matured sufficiently early for the conditions of this area, were taken. Locusts,

in particular the red-wing species, were a cause of considerable anxiety throughout the year. While in general they did but little direct damage to cotton, this crop tended to be neglected by the natives in favour of the threatened food crops. The cotton at Domira Bay was not directly attacked until somewhat late in the season, when it was invaded by young flying swarms. These did considerable damage to the top crop and caused a loss which is estimated at 25 lbs. lint per acre.

The good returns from the cotton at Domira Bay have provided a stock of seed of improved U.4. types which will suffice for an area of not less than 1,000 acres. Arrangements have been made to issue this seed stock, under controlled conditions, to native growers in the Domira Bay area, instead of the station seed being sent to Lisungwe as in the past. It is hoped that the resultant crop will be sufficient to flood the Southern section of the Port Herald area in 1934-35, and provide stocks for the whole of the southern cotton areas in 1936.

The issue of a mixture of high yielding U.4 types, of similar lint character, is thought preferable to the issue of separate strains at this stage in the work.

Staff during the year.—Mr. S. T. Hoyle proceeded on home leave in December, 1932, and returned to Domira Bay in August, 1933. Mr. W. L. Miller proceeded on home leave in July, 1933. Mr. H. C. Ducker took charge of Domira Bay during Mr. Hoyle's absence on leave and on his return proceeded to Makwapala.

EXPERIMENTAL RESULTS.

BY

S. T. HOYLE.

At Domira Bay eleven strains of U.4 were sown in two 6×6 Latin squares, U.4.2. being represented in each trial as a standard of comparison. There was no significant difference between the yields of U.4.2. in the two Latin squares. The yields, expressed as a percentage of U.4.2. were as follows :—

<i>Strain.</i>	<i>Yield</i>
U. 4, Z. 14	120
U. 4.4.2 (955)	115
U. 4, N. 3	109
U. 4, N. 10	107
U. 4, C. 28	104
U. 4.4.2	102
U. 4.2	100
U. 4, N. 4	99
U. 4, N. 5	89
U. 4, N. 9	84
U. 4, N. 8	79

The first two strains are significantly better and the last three significantly worse, for the conditions at Domira Bay this past season, than the standard U.4.2. The actual yields per acre—U.4, Z.14, 870 lbs. and U.4.4.2. (955), 830 lbs. seed cotton per acre—were very satisfactory.

All the above strains were grown in small increase plots, and the more promising will be grown on a larger scale in the coming season, to form the basic seed stocks for issue to native growers in 1934.

The above strain trial is being repeated at Domira Bay this coming season, and replicated at Port Herald and Karonga.

At Makwapala four sub-strains of U.4 were tested in a randomised block layout. The strains used were U.4.2, U.4.4.2, U.4, N.9, and U.4, N.10. The yields were good, U.4.4.2 being the highest with 1,029 lbs. seed cotton per acre, but there was no significant difference between the strains.

Spacing trials were sown at both Domira Bay and Makwapala. Yields in general were good, but no conclusive results were obtained. The Domira Bay trial was to some extent affected by locust damage. The trials at Domira Bay are to be repeated, and a more complicated harvesting technique will be used to try and show up differences more clearly. The harvesting this past year was done in one picking only.

At Port Herald a strain trial similar to that at Makwapala was sown, a spacing trial as at Makwapala and at Domira Bay, and a time-of-planting trial peculiar to this station. The results obtained were very badly affected by the climatic conditions and the locust attack, and no reliance is being placed on them. In the time-of-planting trial locusts destroyed the whole of one "block" and parts of others.

All trials at Port Herald are to be repeated in 1933-34 season when it is hoped that better results will be obtained.

Breeding Material.—The single-plant selections from last year were grown in progeny rows, and mass selections made from the best of these; all selected material was self-fertilised and will be sown as progeny blocks in the coming season.

Four new introductions were grown, two from the Sudan and two from Uganda. The former were jassid-susceptible and cropped but poorly, but the latter showed quite fair resistance. Mass selections were made which will be carried on to next year. It is thought that the Uganda strains S.G.27 and S.G.29 will provide some valuable material for cross-breeding purposes.

Some of the U.4 × Cambodia crosses looked particularly promising, and should be useful in evolving a specialised type for the Lower River areas, which with their erratic rainfall and long growing season

probably require a cotton with a longer fruiting period than that of U.4. In this connection it is interesting to note that some plants from the mixed Moco cotton sent by Dr. Harland have set a number of bolls late in the season, some with good quality lint. Though these Moco plants were badly attacked by jassid and are obviously unsuited to the environment as they stand, they may prove to be useful breeding material.

The U.4 $\times$ Over the Top crosses produced some very early maturing plants which may prove most useful, particularly for the higher elevations.

Certain of a range of crosses supplied by Dr. Harland showed a good deal of promise. Mass selections of self-bred material with white lint were made from them and will be sown this coming season.

The jassid-resistant selection from Dr. Harland's Big Boll cross proved very true to type. Mass selections of selfed material were made in the progeny block sown to this selection and in addition further mass selections were made in a plot which had been sown with the parent bulk.

Bulk returns.—A total of 59 acres were planted this past season with U.4 types. The gross yield from this area was 44,270 lbs. seed cotton. On the basis of these figures the yield per acre is 750 lbs. seed cotton, or approximately 250 lbs. lint per acre.

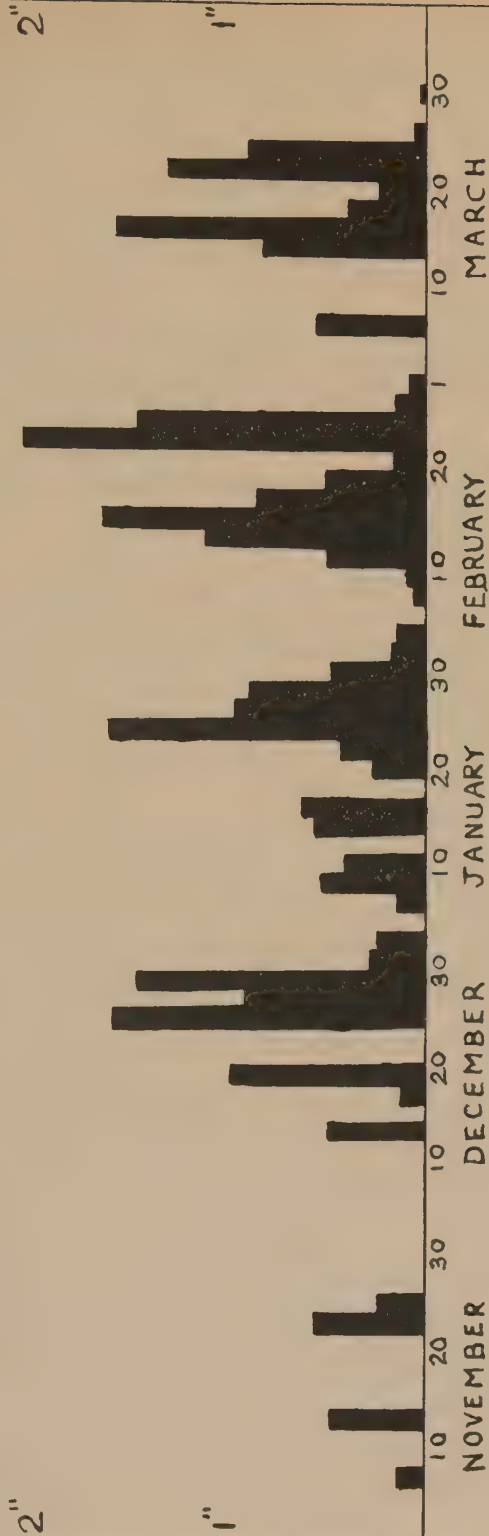
It was estimated that approximately 25 lbs. lint per acre were lost owing to locust damage. Several large swarms of red-wing locusts invaded the fields just prior to harvest. At least 75% of the cotton was defoliated, and nearly 50% barked. This barking resulted in much boll-shedding. Fortunately, dry weather enabled much shed material to be harvested. The loss would otherwise have been far greater than it was.

LILONGWE.

The cross-bred material, which has now been mass-selected for three seasons at the Likuni Experimental Station, was again grown in an area believed to be a "frost hollow." It was decided this past season to commence single-plant selection and some fifty-six plants were selected. These are to be sown this next season in progeny rows on rather better soil than has been used for the mass selection plot. By so doing it is hoped to obtain the maximum amount of seed from the better rows.

DOMIRA BAY RAINFALL 1932-33

TWO-DAY TOTALS (INCHES)



TOTAL FOR SEASON 30.03"

NIGERIA

SUMMARY OF THE WORK CARRIED OUT AT THE CORPORATION'S SEED FARM, DAUDAWA, NORTHERN NIGERIA, DURING THE YEAR 1933.

BY

G. BROWNE AND A. E. CASEMENT.

CLEARING.

The only clearing done during the year was on two Co-operative Farms, as it has now been decided definitely not to extend the Main Farm until the necessity arises for a larger amount of seed cotton to be produced. The two farms cleared lay on quite good land, and the breaking and cultivation were done by hand.

CROPS.

Cotton.—In the full report published last year, a complete schedule of the growing crops on Daudawa at the time of writing was given. Included in this were 260 acres of Strain "L" and 390 acres of B.C.G.A. Commercial on the Main Farm, and 75 acres of Strain "L" on the Co-operative Farms. It will be recalled that Strain "L" was a special strain sent by the Agricultural Dept. from Maigana for multiplication.

Both types of cotton on the Main and Co-operative Farms kept fairly free from disease, and, owing to the excellent incidence of the rainfall, etc., gave promise of far above average yields in October and November. The final yields, however, fell considerably below expectations; the plants apparently became short of moisture for the crop they carried, and eventually shed large numbers of flowers and young bolls. Another shower at the end of October would have made all the difference. The result was a slight drop in the average yield per acre over the farm as compared with the previous year. The crop on the whole, however, was more consistent than hitherto. Although Strain "L" was given the optimum planting period, this turned out not to be so favourable in this particular season owing to the rainfall being poor during July, and it consequently did not get so good a start as the other cotton planted on the farm. This, no doubt, accounts for the fact that the special strain shows a

slight decrease of 2 lbs. per acre as compared with the B.C.G.A. Commercial. When all circumstances are taken into consideration, it may be assumed that the special strain showed up well in comparison.

The total weight of seed cotton produced on the Main Farm was 154,361 lbs., of which 61,311 lbs. were Strain "L." The Co-operative Farms gave 10,510 lbs. which brought the total of Strain "L" up to 71,821 lbs. The average yield of seed cotton per acre on the Main Farm of Strain "L" was 236 lbs. and of B.C.G.A. Commercial, 238 lbs. per acre. The average yield per acre over the whole of the Main Farm was 237 lbs. as against 247 lbs. per acre last year. The highest average yield per acre for any one field of 20 acres was 315 lbs. against 367.5 lbs. per acre last season. On the Co-operative farms the average yield was 140 lbs. per acre as against 262 lbs. in the previous year, with the highest yield per acre from any one farm 271 lbs. compared with 390 lbs. per acre in 1932. The lint returns were: Strain "L," 20,106 lbs. and B.C.G.A. Commercial 25,680 lbs.; making a total of 45,786 lbs. of No. 1 quality cotton. The No. 2 grade lint amounted to 570 lbs. All the lint was sent home to be sold and realised good prices. The seed from the Strain "L" cotton, weighing 51,400 lbs., was sent to the Dan Ja area to be distributed among chosen farmers for further multiplication. This area is more or less closed, and lends itself very well for the purpose of re-collection of seed-cotton produced from the seed sent there from Daudawa for multiplication. Of the seed from the B.C.G.A. Commercial cotton, 16 tons were sent to various farms of the Agricultural Department to be used as cattle fodder, and the remainder was kept at Daudawa for the same purpose.

Owing to the success of Strain "L" last season at Maigana and other stations, it was decided that this should form the only cotton grown at Daudawa for the present year. The seed from the 1932 crop at Maigana, amounting to almost 3 tons, was sent to Daudawa to be planted on the Main and Co-operative Farms. As the total area for cotton was 660 acres on the former and 99 acres on the latter, this allowed for a seed-rate of about $8\frac{1}{2}$ lbs. per acre. While this rate was apparently ample, provided that the season was a good one, last season's experience was not lost sight of and planting commenced on the 3rd of July at the rate of two seeds per hole. In view of the abnormal wetness of the planting and post-planting periods, this was fortunate, as sufficient seed was left for the heavy supplies which were found necessary owing to the very poor germination and washing out. For the same reason, planting was not completed until August 11th. Germination was particularly poor, especially in the earlier-sown fields, which were intercropped, and supplying here practically

meant re-sowing. Owing to the success of intercropping in the previous year, it was decided to inter-plant on a much larger scale this season, so that 80 acres were inter-planted with bullrush millet, 30 acres with maize, and 110 with guinea-corn for silage. This season all the inter-cropped cotton is backward in growth, this being most marked in the area inter-cropped with guinea-corn grown for silage, where the latter had reached a good size before the cotton was sown, but it is less evident where the crops were sown at the same time. August was the wettest month on record at Daudawa with a rainfall of 21.04 ins. as against the previous record rainfall of 16.49 ins. for this month in 1927. During this month the cotton made very little growth, just managing to exist in fact, and consequently later, with the commencement of drier weather in September and as a result of water-logging in the previous month, some of the fields showed signs of leaf-curl and leaf-spot. In view of the already retarded growth of the plants, the outlook for the crop does not look very hopeful especially as the rains finished very early (October 1st). The picking season will probably be later this year and the yields much below average, the crop being in a very backward state at the time of writing (November).

Beans and Groundnuts.—Of the area for beans and groundnuts amounting to 180 acres, 80 acres were planted in *Mucuna* beans and 100 acres in groundnuts. Of the area under *Mucuna* beans 40 acres were inter-planted with bullrush millet and yielded 16,088 lbs. of millet, or 402 lbs. per acre, in the bundle. The whole of the 80 acres were later turned in for green manure, there being a sufficient supply of seed on hand to meet the planting requirements of another year. A quantity of old seed was crushed and fed to the cattle with quite good results, although the price of crushing was rather above the value of the feed.

A quantity of the new variety "Castle Cary" groundnuts, obtained from the Agricultural Department, Samaru, were used to plant 20 acres of this year's crop and will be saved for seed with the intention of planting the whole of next year's area with them. The remaining 80 acres were planted with seed saved from the last year's crop. Of the 100 acres, 20 were inter-planted with millet alone, 20 acres with guinea-corn alone and 60 acres with millet and guinea-corn. The area inter-planted with millet yielded an average of 410 lbs. of millet in the bundle per acre. The crop on the whole has lifted well, but yields are as yet not to hand.

Some green grams, obtained also from Samaru, were planted on the field heads, and after harvesting, the seed was re-sown for seed purposes on 26 acres.

Millet.—Millet was grown as a catch crop over an area of 260 acres, 80 acres in cotton, 80 acres in groundnuts, 40 acres in *Mucuna* beans and 60 acres in guinea-corn alone. This yielded a total weight of 121,672 lbs. in the bundle which gives an average yield per acre of 468 lbs.

Guinea-corn.—Guinea-corn was grown as a main crop on 60 acres, and as a catch crop on 80 acres of groundnuts. On 110 acres of cotton it was grown for silage and yielded an abundant amount of fodder. This leaves a total of 140 acres of guinea-corn to be harvested, and, although the crop is patchy, fairly good yields should be obtained.

Maize.—Maize was grown on 30 acres between cotton and yielded 10,903 lbs. in the cob, which gives an average of 363 lbs. per acre.

LABOUR.

Owing to the commencement of a number of new works locally, labour has been rather more difficult to obtain during the past year. Many of the original employees, including Co-operative farmers, still form the backbone of the labour staff.

An outbreak of smallpox having taken place in the locality, all the inhabitants of the labour camp and staff lines were vaccinated in the early part of the year. There has also been a certain amount of uneasiness on the part of the authorities on account of Sleepy Sickness—caused by Tsetse fly—in the neighbourhood, and the Corporation were asked what could be done regarding the clearing of suspected areas near Daudawa. The Manager, in reply, was able to state that, so far as the Corporation's own labour camp was concerned, all fadamas (or marshy areas) were already being kept clear of the Tsetse fly in order to protect the working cattle. He also gave advice as to the whereabouts of likely breeding places in the surrounding district where it was thought advisable that clearing should be done.

With the exception of a few cases of Guinea-worm and other seasonal complaints the health of the labour staff has been about normal.

The average daily attendance on the farm has been 188 compared with 163 last year. The increase is largely due to the very wet season which necessitated much more work about the farm.

CATTLE AND STOCK.

At the time of writing the last report the strength of the herd had dwindled to 30 head. During the year 72 cattle were purchased, 8 calves were born and 30 beasts have been killed or died. The herd now stands with a strength of 80 all told.

The principal trouble is Trypanosomiasis, and though everything possible is being done to fight the disease, it is still responsible for most of the deaths in the herd. The deaths from Trypanosomiasis have not occurred among the hardest working beasts, but among beasts freshly introduced into the herd during the current wet season; although it is known that there is Tsetse in the vicinity of Daudawa, this fact points to the conclusion that many of the beasts were infected before their arrival at the farm. Most of the beasts also appear to carry latent Tryps. in their blood, and the disease becomes active the moment the resistance of the beast is lowered either by other complaints or work. Almost the whole of the herd have this season been treated for Trypanosomiasis with fairly good results. With a view to lessening the menace and chance of infection, all the low lying parts in the vicinity of the farm, which are marshes (fadamas) in the wet season, were cleared of all shrubs and trees likely to form breeding grounds for the Tsetse fly.

The beneficial effects of dipping are now very evident. Whereas at this date last year almost every beast in the herd was suffering in greater or less degree, from the tick-born skin disease "Kirichi," up to the present there is not a sign of it and a very close examination is necessary to locate a tick on any of the cattle.

During the whole of the year the cattle have done all the necessary carting, and during the working season have cultivated 1,500 acres. A top dressing of one ton per acre of farmyard manure was applied over an area of 130 acres.

Experiments in the building of different types of cattle sheds were made with the object of discovering the most suitable type of house from the points of view of animal health and of manure-making properties. During the dry season water was added to the bedding daily with excellent results.

THE GINNERY.

A total of 166,804 lbs. of seed cotton passed through the ginnery, producing 46,356 lbs. lint; 119,729 lbs. seed and 721 lbs. waste.

WATERWORKS.

An extension was made to the pipe line to take the water from the old tap at field 10 out to the centre of the farm at the junctions of fields 9, 8, 14 and 15 where a cattle drinking trough was erected. A well was also sunk beside Co-operative Farm D2. At a depth of 36 ft. a good supply of water was found, which will meet the requirements of at least 6 farms and so save pipes and a tank.

A caisson has been installed at the pump house and a small concrete dam to raise the water level around it and so to keep sufficient water in the caisson to supply the demands put upon it. The inclusive cost of this was £52. The water supply is now perfectly clear and the advantages are already seen in the health of the labour and the wear and tear of pumps and boilers.

BUILDINGS.

A silo is being erected at field 7 cattle camp. It is of a permanent nature, being built out of laterite blocks and cement. The first section has been completed and put into use for this season; it has a capacity of 1,360 cu. ft. and the inclusive cost was £16.

Considerable damage was done to buildings by the tornadoes of July and August and repairs have been carried out where necessary.

CO-OPERATIVE FARMS.

During this year two new farms were cleared and cultivated and given to their respective owners. As yet no houses have been built on them, but houses have been erected on the two farms cleared and cultivated last season. This now makes a total of 26 farms under the Co-operative system. The estimated area under cotton is 99 acres this year as against 75 acres last year. The fall in the average yield per acre over the Co-operative farms recorded above in the Cotton section of this report was largely due to the new farmers, who at first planted cereals and later changed their minds and decided to use the land for cotton. No farmer has as yet bought cattle for cultivation, but some farmers, realising the advantage of this form of cultivation, have hired cattle and ploughs from the Corporation to work on their farms for odd days during their busy times. One farmer has now 15 acres under cultivation.

METEOROLOGICAL DATA.

This year holds the record for being the wettest season since the commencement of Daudawa. In June, July and August the rains were exceptionally heavy, considerable wash and erosion occurred on the farm, a number of labour houses and native grain stores completely collapsed and a certain amount of damage was done to the permanent buildings. The crops also suffered heavily.

The real rainy season commenced on the 31st of March, and except for a short dry spell in April, rains fell continuously until the end. The last rain fell on the 1st of October which made an early finish to an extraordinarily wet season with a total of 57·16 inches, which was 11·58

inches in excess of last year and 1.75 inches more than 1927 which held the previous record of 55.41 inches. The Harmattan commenced on the 2nd of October which is much sooner than usual.

LOCUSTS.

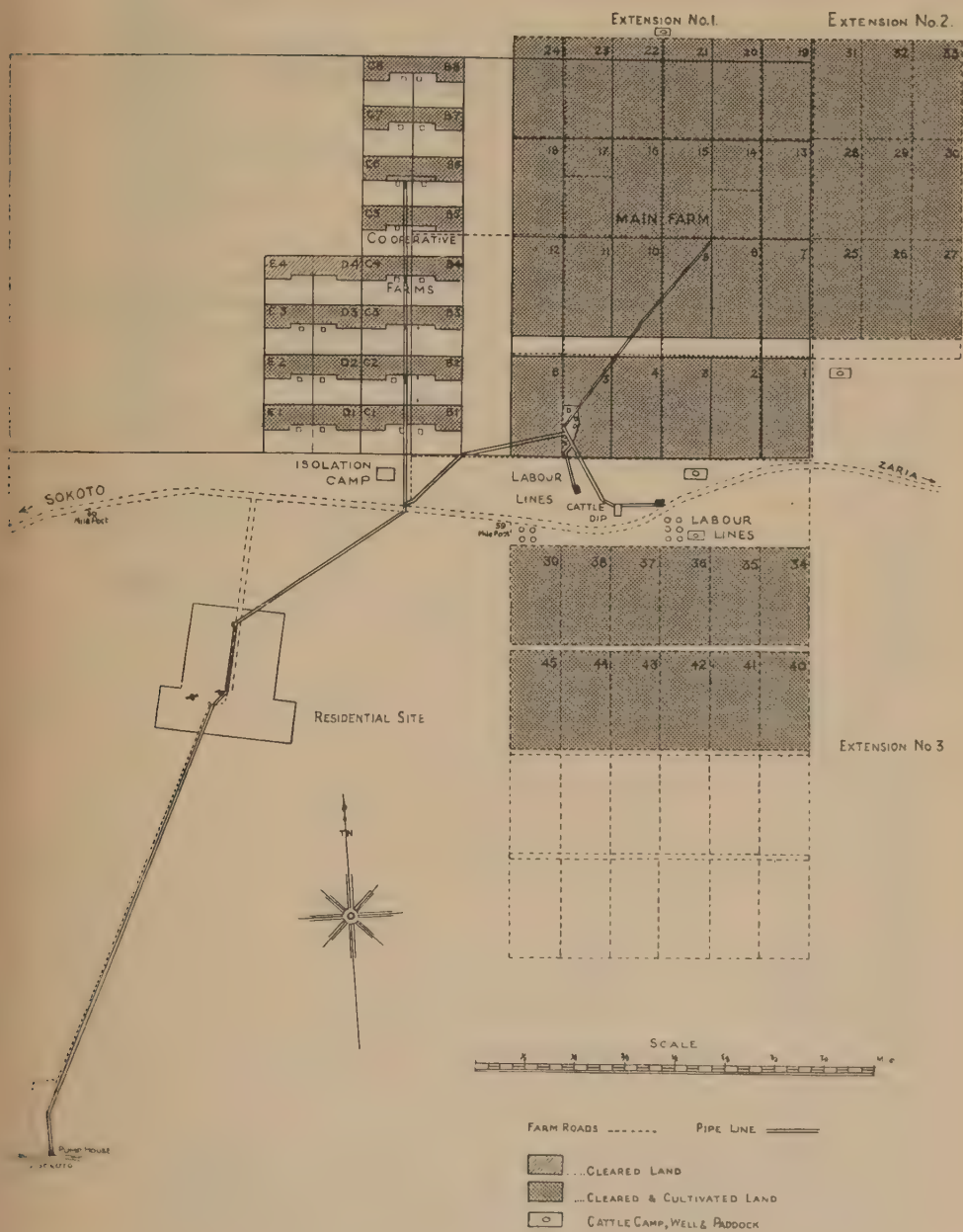
Locusts were numerous in the district all through the season, but on no occasion were any large numbers seen on the farm, nor was any damage reported by the Co-operative farmers.

GENERAL.

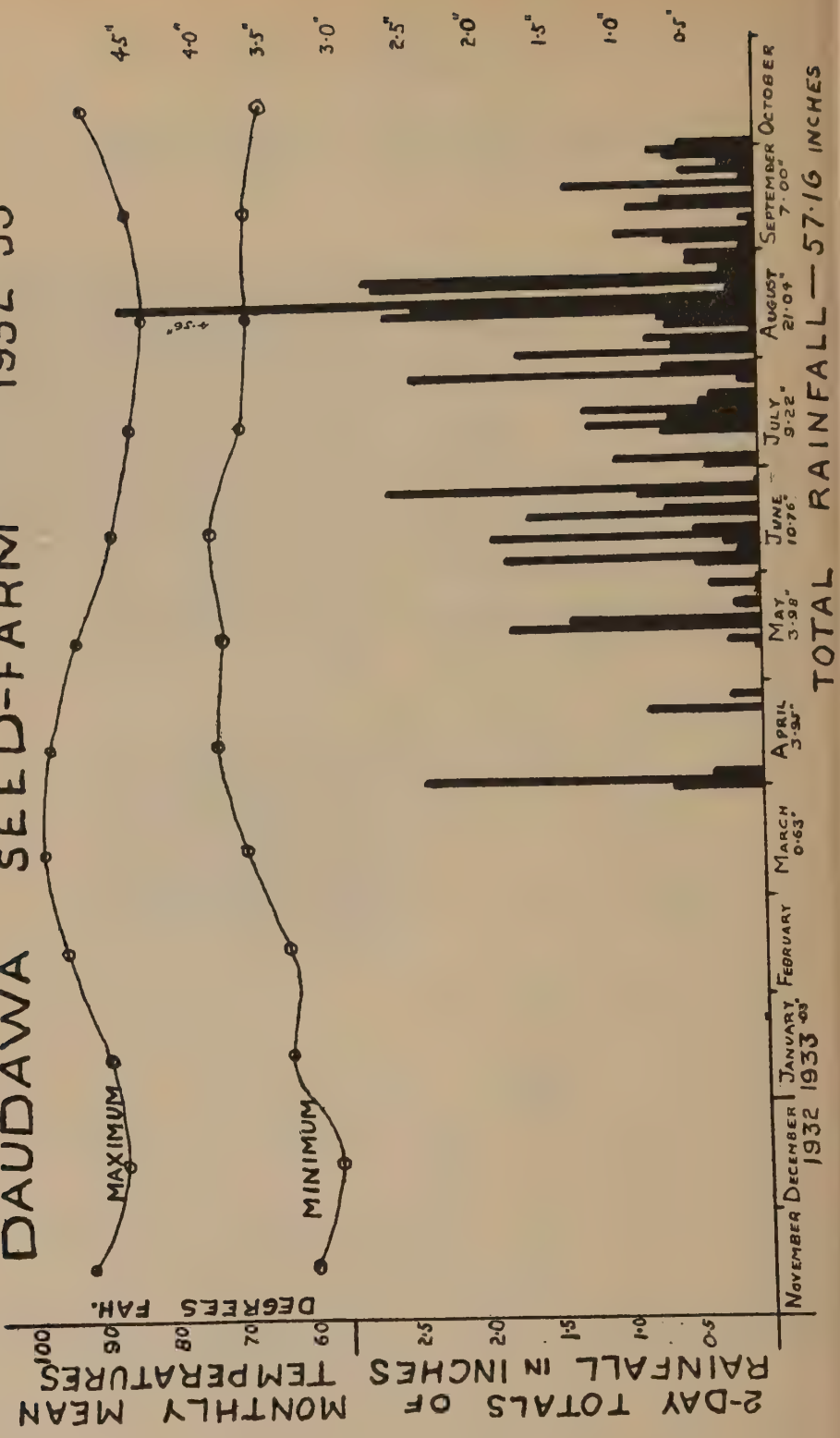
The most important event of the year was the visit of Mr. H. C. Jefferys, who came out to Nigeria on behalf of the Corporation to report on the proposed change in the policy at Daudawa as suggested by the Director of Agriculture. An outline of the proposals is given in the Corporation's last quarterly report. Mr. Jefferys arrived at the beginning of June and stayed about a month in the country. Apart from the primary object of his visit, his wide tropical agricultural experience was most helpful and his advice was greatly appreciated by the staff.

This opportunity is taken once more to express the thanks of the Corporation and their Staff to the Administrative, Agricultural and Veterinary Departments for the friendly co-operation and assistance of their respective officers during the past year.

DAUDAWA SEED-FARM, NORTHERN NIGERIA, 1933.



DAUDAWA SEED-FARM 1932-33



WEST INDIES.

REPORT OF THE COTTON EXPERIMENT STATION, ST. VINCENT, COVERING THE PERIOD 1930-33.

BY

S. H. EVELYN AND S. C. HARLAND.

INTRODUCTION.

The following Report by Mr. Evelyn has been received through, and revised by, Dr. Harland, who is responsible for the direction of the work described. It covers the period August 1st, 1930, to July 31st, 1933.

The St. Vincent Sea Island Cotton Industry dates from the introduction of seed from the Sea Islands in 1903.

As early as 1915 St. Vincent was known to produce the best and finest cotton in the world, and this reputation was maintained until 1928 when reports were received from the brokers and spinners that St. Vincent cotton had deteriorated considerably in quality. The complaints were that the lint was (a) irregular in length, and in many cases very coarse and wanting in strength, (b) of a very crimped appearance as against the commercially "open preparation" of the product of other Islands—a serious deterrent to most buyers—and (c) dirty—containing fragments of leaf and bract and a considerable amount of stains.

Prior to 1929 cotton was planted in St. Vincent in the months of June and July, and reaped in October, November and December. It was considered that as October and November were the wettest months of the year the poor appearance of the cotton was due in large part to its being reaped in a wet condition and sent to the ginneries damp. Chiefly on this account the planting season was changed in 1929 to September. As this month of planting carries the crop into another year, in this report the year of planting will designate the crop period.

A fundamental fact to be borne in mind at this juncture is that for many years prior to 1930 the Island had produced two quite distinct grades of Sea Island cotton. These are respectively referred to below as "Ordinary," and "Superfine" or V.135.

The Ordinary crop, of a staple length of 51 mm., had always formed the bulk of the production and was derived from the original importation of Rivers seed.

The Superfine crop was derived from a distinct introduction of particularly fine quality known originally as Bleak Hall cotton. From

this Harland isolated a strain—V.135—with a mean maximum lint length of 57 mm. which is considered the longest and finest cotton in the world, commanding a price much higher than that of other cottons.

In 1924 the policy of the Agricultural Department was to bulk up separately these two types of seed for distribution to the parties growing one or the other. By 1928 there was a good deal of mixture of the Superfine and Ordinary all over the Island and frequent complaints on the deterioration in quality led to the matter being investigated by Professors Ballou and Cheesman of the Imperial College of Tropical Agriculture.

They found much variation in length and quality of lint, and this was attributed to the occurrence of natural crossing between the two types, and in lesser degree to environmental factors. A small number of naked black seeds was also found.

Field and laboratory examinations made by Professor Cheesman of the strains grown at the Experiment Station in pedigree culture demonstrated that a certain amount of impurity existed in many of these, also due apparently to natural crossing between the two types.

The seriousness of the situation led to the conclusion that the appointment of a whole time cotton officer was urgently necessary ; the Empire Cotton Growing Corporation were therefore approached with the result that the Station that they had maintained in the Island from 1920–1926 was re-opened in July 1930.

SUMMARY.

1. The present report covers the period 1st August, 1930, to the 31st July, 1933.

2. In brief, it can be stated that the climatic conditions were excellent for the 1930–31 season but too wet for the remaining seasons.

3. As regards the commercial crops of cotton in St. Vincent, since 1929, when the month of planting was changed from June to September, damage from pests can be said to have been negligible. As the reaping season now occurs in the dry months of January to May the cotton is cleaner, whiter and the percentage of stains negligible, whereas formerly cotton was reaped in the wettest months (October–December) and much dirty, stained lint of a crimped appearance resulted.

4. The Station, which had been maintained by the Empire Cotton Growing Corporation from 1920 to 1926, was re-opened in July, 1930, primarily with the view of purifying the local seed supply. It was also decided that the Station should be complementary to the Cotton Research Station in Trinidad, and that the work of the former should be technically directed by Dr. Harland.

5. The decision was reached that St. Vincent being the only place in which the longest stapled Sea Island Cotton was grown—that type (V.135) should be exclusively cultivated.

6. Details of the purification of the superfine strain V.135 and of the production of sufficient seed of this type to plant the Island's crop, in September, 1932, are given in the Report, together with the technique employed.

7. As V.135 was always regarded as a low yielding strain an experiment was undertaken with the object of increasing its yield by selection of high "bolling" plants. This experiment has led to the hypothesis that node number in the V.135 strain is an important indicator of yield—a significant negative correlation being obtained between node number and the characters "shedding," "budding" and "bolling." The results up to date support this theory. From the results so far obtained selection of high "bolling" plants also appears to be sound.

8. To increase the yield of V.135 hybridization experiments between V.135 and a high yielding strain of Montserrat Sea Island were undertaken. The best F_1 was backcrossed to the Montserrat parent and from the "selfed" backcross two very promising selections, combining long lint and high yield, have been made.

9. To facilitate the detection of rogues in any commercial field, the red plant body of the perennial Peruvian type Trinidad Red Kidney has been transferred to V.135. The character red plant body in this case is linked with weak petal spot and is allelomorphic to green plant body and strong petal spot, so that any plant appearing in a commercial field of this Red Sea Island strain with a green body or strong petal spot can be rogued out as a vicinist without resource to lint and seed analysis.

10. Owing to the very poor quality and yield of lint obtained from the cultivation of 6,000 acres of the Bourbon type (*G. purpurascens*) or, as it is commonly called, "Marie Galante" or "Silk Cotton," in the Grenadines—Carriacou, Union Island, Canouan and Mayreau—it was decided to replace the existing type by either of two strains (a) Moco, a Bourbon type which is grown extensively in North Brazil or (b) an improved selection of the existing Marie Galante discovered in Carriacou by the Agricultural Instructor of that Island. Purification of several Moco strains has been accomplished at this Station, but on testing, these have all been found lacking in staple strength, whereas very excellent reports have been obtained from the spinners and brokers on samples of the improved Marie Galante which is now designated Carriacou 1 or C.1. A scheme for the field-testing of Moco and C.1 in Carriacou is now in progress as it is hoped that the dry

conditions of Carriacou will do much to improve the strength of the Moco staple. Seed of a few pure strains of C.1 is also being multiplied this year, and it is hoped by July, 1935, to be able to replace the existing commercial cotton in all the Grenadines that grow perennial types with C.1, or with Moco if its staple length improves.

Hybridization work has also been undertaken with these types, and the F_1 of Moco $\times$ Marie Galante gave better results than either parent. It has, therefore, been backcrossed to Moco for further study.

11. A series of hybridization experiments undertaken by Dr. Harland with the object of improving the U.4 strains have given very promising results. The following types were used in all combinations with the object of increasing the genetic variability of U.4 so that selection for any particular environment would be facilitated:—(1) Cambodia, (2) two strains of Parnell's U.4, (3) Jamaica Xerophytic—a hairy Bourbon perennial from Jamaica, (4) Type 57—an Upland with lint index 100 mg., (5) Gambia—a prolific type allied to Bourbon and native to the Gambia, and (6) Galapagos—a hardy prolific native variety from the Galapagos Islands. The strains were considered relatively pure enough and so "selfed" seed has been sent to Barberton, Southern Rhodesia, Northern Rhodesia, Nigeria, Nyasaland, Swaziland, Sudan and Uganda for trial.

12. The experiment to determine how far the characters "Shedding," "Budding" and "Bolling" are hereditary in Sea Island cotton demonstrates that without controlled environment there is little possibility of significant results being obtained. It is, however, obvious from former and present work that these characters are to a certain extent hereditary.

13. An experiment was undertaken to determine whether viability of cotton seeds can be maintained longer in cold storage than at room temperature in St. Vincent. Seed was kept in cold storage at 45° F. and a control batch at room temperature (80° F.). The longevity of the control seed was greater than that kept at 45° F., and it is suggested that the results obtained from the seed stored at 45° F. can be attributed to either or both of the following reasons (a) moisture formation in the parcel of seed and (b) the temperature of the storage room not being maintained at a constant degree.

TECHNIQUE EMPLOYED AT THE STATION.

As certain of the methods used at this Station may be of interest to other cotton workers, a detailed account of the technique employed is recorded.

PEDIGREE CULTURE SYSTEM.

Field Operations.

The plots are forked and a green dressing of Bengal Beans or Black Eye Peas turned in, and banks 4 feet apart hoe-made.

Seed is sown on the top of the bank—2 feet apart for annual cottons and 6 feet apart for perennials.

A progeny row consists of 30–50 plants, the number depending on the purity of the strain.

Stencilled wood labels are placed at the head of each row, and each plant in each row is numbered consecutively with a luggage label tied as high up as possible on the plant. The number is written in India ink. These labels last throughout a season at this Station where the rainfall is 90–100 inches per annum.

Field Observations.

1. Percentage germination, and causes affecting germination.
2. Abnormalities.
3. Node number at date of first flower. The first node is the two cotyledonary scars—the last the scar before the first sympodial branch.
4. Number of buds shed from the main axis sympodia at the date of first flower.
5. Number of buds present on the main axis sympodia at the date of first flower.
6. Colour of plant body. This is necessary when red-bodied strains are being grown.
7. Corolla colour grade. Mean of three determinations per plant. A modification of the chart in use at the Cotton Research Station, Trinidad, is employed.
8. Corolla spot grade. Mean of three determinations per plant. Chart as used at the Cotton Research Station, Trinidad.
9. Leaf callus grade. Mean of three determinations per plant. Chart made at this Station.
10. Leaf shape and hairiness. Necessary when leaves of varying shapes and hairiness are being observed.
11. Number of bolls present on the main axis sympodia at the date of first boll-split.
12. Mean number of loculi per boll. Mean of 30 bolls per plant.
13. Mutations.
14. Incidence of pests.
15. Incidence of diseases, e.g., Angular Leaf Spot—counts made at weekly intervals and plants attacked marked with strips of turkey-red to avoid re-examination.
16. Climatic observations.

Self-fertilization.

Four-inch lengths of fine white twine are employed. The bud is tied with one knot on the day preceding anthesis, and is tagged the next morning with the same length of “selfing” twine around the pedicle of the flower, provided the tie has not been forced off. This obviates the risk of harvesting tagged “unselfed” bolls. At least ten bolls on each tree are “selfed.”

Harvesting.

A bulk sample of seed cotton of 100 normal “unselfed” bolls, representative of the row (i.e., with 50 plants to the row—two bolls are harvested from each plant), is harvested, in cloth bags measuring 18 inches × 9 inches with twine handles. The bags, each carrying two luggage labels one inside and one outside, are taken into the field on a bamboo pole and dropped off at each corresponding row label. The number of bolls collected is recorded on the label at each harvest until the requisite number is obtained. Even after the bulk samples are collected, “unselfed” cotton is always picked before “selfed” cotton, as this reduces the risk of mixing. The bulk samples are dried for seven hours in the sun before weighing.

For "selfed" seed cotton, cloth bags 5 inches $\times$ 3 inches in size are used. The metal eye of a big hook-and-eye is sewn on the top of one side of the bag and the bags constituting a row are suspended from the eye on a length of stiff wire. A length of three feet carries thirty bags comfortably. Each bag bears a number in India ink on the outside of the bag corresponding to the number of the plant. A small paper label is placed inside the bag in case the outside number gets erased. Each wire rod carries a luggage label corresponding to its row label. The rods with the bags are placed on a portable bamboo frame on which they are replaced in order after each harvest. This saves time and obviates risk. As soon as "selfed" harvesting is completed the bags of "selfed" seed are sun-dried, then taken off their rods and suspended from their metal eyes on nails in the office. Each row constituting a strain is labelled.

Bulk Sample Analysis.

The following data are recorded for each bulk sample :—

1. Weight of seed cotton of 100 bolls, and so weight per boll, in grams.
2. The mean of 25 measurements. Twenty-five normal locks of seed cotton are selected and the middle seed of each lock with lint attached is combed and measured. A sharp pointed instrument, e.g., a coarse entomological needle, is used to divide the lint on each side of the raphe and back of the seed. The lint is now divided in half. With the beak of the seed facing the comb the left portion of the lint and left part of the seed is gripped by the thumb and first finger of the left hand while combing is lightly done on the right portion of the lint from the seed outward. Having combed a little way from the seed, it is tightly gripped together with the combed portion of the lint with the thumb and first finger of the left hand, and the remainder of the lint is then combed freely without danger of tearing it from the seed. As soon as the comb runs freely through the right portion of the lint, the combed lint near the seed is tightly gripped by the thumb and first finger of the left hand and the same fingers of the right hand used to pull away any loose hairs from the combed lint. This leaves the combed lint in a bit of a point though not twisted. Approximately 50 of the longest hairs are now gripped with the thumb nail and first finger of the right hand and the raphe of the seed is placed opposite zero on the rule and measurement taken from the raphe to the place gripped. This method is easy and fast and if combing and measurements are done by the same person consistently accurate results are obtained. The above method was evolved by Harland and is in use at the Cotton Research Station, Trinidad.
3. Weight of 300 normal seeds in milligrams. From this the weight of 100 seeds is obtained.
4. Weight of lint from 300 normal seeds in milligrams. From this, the lint index is obtained.
5. Ginning percentage—i.e. $(\text{lint index} \times 100) \div \text{weight of seed cotton of 100 seeds}$.
6. Weight of lint per boll—i.e. $(\text{lint index} \times \text{weight of seed cotton per boll}) \div \text{weight of seed cotton of 100 seeds}$.
7. Mean number of seeds per boll—i.e. $(100 \times \text{weight of seed cotton per boll}) \div \text{weight of seed cotton of 100 seeds}$.

On completion of the bulk sample analysis the rows with the desired characters are selected for single plant analysis and the unwanted rows discarded without further analysis.

Single Plant Analysis.

1. Mean maximum lint length. The mean of five measurements.
2. Weight of 100 normal seeds, in milligrams.
3. Lint index—i.e. weight of lint from 100 seeds, in milligrams.
4. Ginning percentage.
5. Tuft grade. Mean obtained on the tuft grades of five seeds. (Chart as used at the Cotton Research Station, Trinidad.) This observation is very valuable when breeding away from naked seeds.
6. Fuzz grade. Mean obtained on the fuzz grades of five seeds. (Chart as used at the Cotton Research Station, Trinidad.) This observation is very valuable when breeding away from fuzzy seeds.

7. Number of off-type seeds observed, e.g. kidney seeds in certain strains and "split" seeds, as have been observed at this Station in some of the Moco strains, which may be responsible for their bad germination.

From the means of the single plant analyses it is possible to select the best row for any particular character. The best plants can then be selected from the best row for further purification or for multiplying for distribution.

EXPERIMENTAL.

Experiment 1. The Purification of the Island's Crop.

As it was considered impracticable to grow with safety two distinct types of cotton in the Island, it was decided that it would be preferable to grow only one type—Superfine—in St. Vincent. Accordingly attention was directed to the purification and improvement of the V.135. Since length of staple was the determining factor in this experiment, the results are presented in the form of frequency arrays of mean maximum lint lengths. These results indicate very clearly the progress of selection work in respect of this character.

TABLE I.
FREQUENCY ARRAYS OF MEAN MAXIMUM LINT LENGTHS (IN mm.) OF V.135.

	41	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	n.	Mean.
(1) S.P.A. ¹ of progeny rows Season 1929	1	1	1	8	5	5	10	8	13	10	27	27	42	30	20	10	2	-	-	-	220	54.5
(2) S.P.A. of 50 selections for planting progeny rows in Sept. 1930	1	-	-	1	-	-	-	1	1	-	-	1	16	17	10	2	-	-	-	-	50	57.1
(3) B.A. ² of the 50 progeny rows—Season 1930	-	-	-	1	1	-	-	-	1	1	-	3	4	13	16	18	2	-	-	-	50	57.0
(4) B.A. of the 8 progeny rows selected for S.P.A. from (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	2	-	-	-	8	59.3
(5) S.P.A. of the 2 best progeny rows from (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	13	11	4	-	40	60.1
(6) S.P.A. of the 12 best plants selected from (5) for planting progeny rows in Sept. 1931	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	4	-	-	12	61.3
(7) S.P.A. of 150 plants from (4) multiplied at Pembroke Estate in Sept. 1931	-	-	-	-	-	-	-	-	-	-	-	-	11	25	58	37	16	3	-	-	150	59.2
(8) B.A. of the 12 progeny rows planted in Sept. 1931	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	7	-	-	-	12	59.6
(9) B.A. of the 4 best progeny rows selected for S.P.A. from (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4	60.0
(10) S.P.A. of these 4 progeny rows ...	-	-	-	-	-	-	-	-	-	-	-	-	1	6	13	29	21	8	1	1	80	59.2
(11) S.P.A. of the 2 best progeny rows of (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	11	14	6	1	1	40	59.7
(12) S.P.A. of the 2 best plants from (11) selected for planting progeny rows in 1932	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	2	62.5
(13) B.A. of the 2 progeny rows planted in Sept. 1932	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	2	59.5
(14) S.P.A. of 40 plants of these two progeny rows	-	-	-	-	-	-	-	-	-	-	-	-	2	6	14	11	5	2	-	-	40	58.4
(15) S.P.A. of the 2 best plants selected from (14) for planting progeny rows in Sept. 1933	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	2	60.5

¹ S.P.A. = Single Plant Analysis. ² B.A. = Bulk Analysis.

Explanation.—(1) Represents the mean maximum lint length results obtained by Cheesman and the writer on single plants of the progeny rows grown at the Station in September, 1929. From these, 50 selections were made (2); of these 5, although below 57 mm. in length, had such high lint indices as to merit further study. Progeny rows of 30 plants of each of the 50 selections were sown out in September, 1930, and each plant of each row “selfed” and the “selfed” seed collected separately. A bulk sample was harvested from each row and measured (see (3)). The two rows, giving 47 and 48 mm. respectively, proved to be of the type designated “Sea Island White,” and as they bred true for white corolla the best plant was selected to retain the type. Of the fifty strains, the eight best with mean maximum lint lengths of 59 mm. and over were selected for single plant measurement (see (4)). Approximately 20 plants were measured of each of the eight strains. The two rows having the highest mean maximum lint lengths were selected (5), and the 12 single plants with the highest mean maximum lint lengths were selected for planting in progeny rows in September, 1931 (6). The “selfed” seed of the remaining six selected rows, together with that of those non-selected plants of the two best rows (7), was bulked and was sufficient to plant a multiplication plot of ten acres in an isolated area at Pembroke Estate in September, 1931. The same procedure was carried out with the twelve strains planted in September, 1931—the bulk analysis of which is represented by (8). Of these twelve rows the best four (9) were selected for single plant analysis (10). Of these four strains the two best were selected (11) and a single plant of each with the highest mean maximum lint length was selected for planting in progeny rows in September, 1932 (12). Of the remaining plants of the twelve strains 50 plants having 5% bud shedding and under, at the date of first flower, and 36 plants having 70 bolls and over at the date of first boll-split were selected and planted as a multiplication plot at the Station in September, 1932. The remaining “selfed” seed from the twelve progeny rows was bulked and was sufficient to plant a thirty-acre multiplication plot in an isolated area at Diamond Estate in September, 1932. The seed from the Pembroke Plot was given out to planters in September, 1932, and this was used almost exclusively. Measurements were performed as formerly on the bulk samples of the two progeny rows planted in September, 1932, but owing to unfavourable climatic conditions the figures were not as high as had been expected (13). Each plant of each progeny row was measured (14). From the single plant analysis two plants were selected (15) for planting in progeny rows in September, 1933. In order to judge the results of this selection

work representative samples of seed cotton were obtained from estates and peasant-holdings situated in different parts of the Island and 50 seeds of each sample were combed and measured. In the following table the results are recorded, together with those of (a) a representative sample of the Island's 1931 crop, which is included as a control, being representative of the cotton grown prior to the liberation of seed from this Station, (b) a sample of the Pembroke Multiplication Plot seed planted at this Station in September, 1932, as a check on the Island's crop from the same seed, (c) a sample of the Diamond Multiplication Plot, the seed of which forms the Island's 1933 crop and (d) a sample of the Station's Multiplication Plot which was multiplied in September, 1933, and will be liberated in September, 1934.

It will be noticed from Table 2 that the Grand Sable results are in two arrays—the first represents estate selection from the estate's 1931 crop, which is obviously impure, the other that of seed of (d) obtained from the Station, but after planting was probably supplied from the first, thus accounting for the three measurements below 55 mm. The arrays demonstrate that with a few exceptions, notably Belmont and Stubbs, where probably seed of the planters' own selection was used, the Island's cotton is again pure. With regard to the other short lengths recorded it should be mentioned that these were invariably associated with shrunken undeveloped seeds.

In Table 2, samples from estates and peasants are differentiated by (E) and (P) respectively.

TABLE II.
MEASUREMENTS (IN mm.) OF THE ST. VINCENT 1932-33 COTTON CROP.

Location.	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	Mean Max. Lint Length.
Grand Sable (E) 1931 ...	1	2	1	4	3	4	2	4	6	12	6	—	3	2	—	—	—	55.3
Grand Sable (E) (d) ...	—	—	—	—	—	—	1	2	4	8	15	11	4	2	1	2	—	57.2
Richmond Vale (E) ...	—	—	—	—	—	—	—	3	10	12	10	6	6	1	2	—	—	57.8
Peter's Hope (E) ...	—	—	—	—	—	—	—	3	6	22	13	3	3	—	—	—	—	57.3
Brighton (E) ...	—	—	—	—	—	—	1	—	3	8	23	11	2	1	1	—	—	57.1
Mustique IIs. (E) ...	—	—	—	—	—	—	—	—	4	15	17	8	4	1	1	—	—	58.0
Sandy Bay (P) ...	—	—	—	—	—	—	1	4	2	15	10	9	5	3	—	—	1	58.0
Villa (P) ...	—	—	—	—	—	—	—	2	4	16	12	7	3	4	1	1	—	58.1
Prospect (P) ...	—	—	—	—	—	—	2	—	6	13	11	6	7	5	—	—	—	58.0
Rabacca (P) ...	—	—	—	—	—	—	—	1	3	27	12	3	4	—	—	—	—	57.5
Stubbs (P) ...	—	—	—	1	1	1	3	5	9	16	9	5	—	—	—	—	—	58.5
Villa (P) ...	—	—	—	—	—	—	—	2	10	21	11	3	2	1	—	—	—	57.3
Waterloo (P) ...	—	—	—	—	—	—	—	1	6	5	25	7	2	3	1	—	—	57.1
Belmont (P) ...	—	—	—	2	1	7	6	10	1	12	5	6	—	—	—	—	—	55.5
Brighton (P) ...	—	—	—	1	—	2	1	3	10	17	7	3	5	1	1	—	—	57.0
Slon Hill (P) ...	—	—	—	—	1	2	—	—	4	8	21	9	2	1	1	—	—	56.9
New Ghent (P) ...	—	—	—	1	2	—	—	—	4	16	12	3	2	3	2	—	—	57.3
Arnos Vale (P) ...	—	—	—	—	1	2	2	1	7	13	11	9	2	1	1	—	—	57.3
Arnos Vale (P) ...	—	—	—	—	—	2	2	6	8	15	10	4	1	2	—	—	—	56.9
Richmond Hill (P) ...	—	—	—	—	—	1	—	—	4	15	15	4	6	5	—	—	—	58.1
Villa Point (P) ...	—	—	—	—	—	—	—	—	3	5	13	18	4	6	2	—	—	57.8
Ratho Mill (P) ...	—	—	—	—	—	—	—	—	—	2	15	17	7	6	3	—	—	58.2
Fountain (P) ...	—	—	—	—	—	—	2	2	3	8	17	10	4	1	2	1	—	57.1
Prospect (P) ...	—	—	—	—	—	—	—	2	4	4	16	10	8	—	—	1	—	57.6
Belvidere (P) ...	—	—	—	—	—	1	1	1	7	5	16	6	7	2	3	1	—	57.2
Fountain (P) ...	—	—	—	—	—	—	—	2	5	13	12	5	7	5	1	—	—	58.2
Ratho Mill (P) ...	—	—	—	—	—	—	1	2	2	5	13	13	9	4	1	—	—	57.6
Totals ...	1	2	1	9	10	29	27	87	157	444	295	133	89	50	13	2	1	57.3
(a) Control ...	—	—	—	—	—	—	7	5	3	6	7	3	2	—	—	—	—	53.8
(b) Pembroke Seed ...	—	—	—	—	—	—	—	2	7	16	12	7	5	1	—	—	—	57.7
(c) Diamond M.P. ...	—	—	—	—	—	—	—	1	10	15	12	8	3	1	—	—	—	57.6
(d) Station M.P. ...	—	—	—	—	—	—	—	—	5	6	11	8	8	4	—	1	—	59.1

It is of interest to record that in the Season 1932 a yield of nine bales of lint was obtained at Brighton Estate from eight acres of the purified V.135 strain, i.e., 405 lb. of lint per acre. This result disproves the old idea that V.135 is a low-yielding strain, particularly when it is considered that the climatic conditions during the 1932 season were not conducive to high yields and that owing to the depressed state of the cotton market planters are not cultivating their cotton as well as they did when better prices prevailed.

The following is extracted from a report received in October, 1932, from the Fine Cotton Spinners' and Doublers' Association, Limited, on samples of V.135 purified at this Station :—

"The spinning quality of the Experiment Station cottons is exceptionally good. These cottons are among the best we have spun here and we have to go back to a V.135 strain (1928 crop) to find a cotton of equal merit."

The remarks on samples of estate cotton sent as a control were :—

"The control sample is so inferior that it can hardly be called a control. It is, however, typical of much of the available commercial Sea Island Cotton of the year (1930)."

The characters of the V.135 strain now being liberated for planting in September, 1933, are as follows :—

TABLE III.

Mean Max. Lint Length (mm.).	Wt. of seed cotton per boll (gm.).	Wt. of lint per boll (gm.).	Mean no. of seeds per boll.	Wt. of 100 seeds (mg.).	Lint Index mg.	Ginning %.
58.7	3.06	0.71	18.7	126	38	23.2

Experiment 2. The Improvement of the Agricultural Properties of V.135.

The question of the purification of the Island's crop having been settled, by adopting a system of annual renewal of pure seed from Departmental sources, attention was paid to the improvement of the agricultural properties of the strain V.135.

At this time it was thought that high "bolling" plants could be obtained by selection of parents with initial low "bud-shedding." Consequently selections were made in 1931 of all plants in the V.135 progeny rows with (A) 5% bud-shedding, at the date of first flower, and under and (B) 70 bolls and over at the date of first boll-split. The selfed seed of each group was bulked and sown separately in the field.

In the context the terms "shedding" or "sheds," "budding" or "buds" and "bolling" or "bolls" refer to "buds shed from the main axis sympodia at the date of first flower," "buds present on the main axis sympodia at the date of first flower" and "bolls present

on the main axis sympodia at the date of first boll-split " respectively.
The selections are recorded in Table 4.

TABLE IV.
SELECTIONS FOR EXPERIMENT 2.

Plot.	Strain.	Shedding %.	Bolling.	Plot.	Strain.	Shedding %.	Bolling.
A	V.13- 2-14	4.8	62	A	V.46- 3-10	2.0	76
	-20	4.3	66		-15	2.1	63
	V.13-11- 5	5.0	74		-20	3.9	64
	- 6	3.9	67		V.46- 6- 1	0.0	74
	-10	3.8	46		- 3	1.9	59
	-16	2.4	27		- 5	4.8	73
	V.13-13- 4	3.5	61		- 6	2.2	49
	- 5	4.1	40		-10	4.8	32
	-20	4.4	65		-12	2.1	40
	V.13-26- 4	0.0	71		-13	4.7	44
	- 5	1.0	50		-14	4.3	37
	- 6	1.8	64		-19	4.7	42
	V.13-27- 5	1.9	49		V.46-15- 2	5.0	73
	V.13-29- 5	3.5	76		- 3	3.6	72
	- 6	4.0	57		- 5	3.8	53
	- 9	4.2	33		-10	3.6	62
	V.46- 1- 4	4.7	44		-11	4.8	31
	-20	1.9	71		V.46-16- 1	3.7	95
	V.46- 2- 1	3.6	75		- 4	3.9	58
	- 6	3.4	75		- 7	4.8	43
	V.46- 3- 2	4.0	59		- 8	3.5	64
	- 3	3.5	67		- 9	4.4	35
	- 5	4.9	77		-10	4.1	50
	- 7	4.9	78		-11	3.9	78
	- 8	3.6	49		-13	1.9	56
B	V.13- 2- 1	13.6	77	B	V.46- 3- 1	9.5	92
	- 4	6.5	75		- 5	4.9	77
	V.13-11- 1	6.2	88		- 7	4.9	78
	- 5	5.0	74		- 9	10.9	70
	V.13-13-14	10.3	71		-10	2.0	76
	V.13-26- 4	0.0	71		-11	5.5	72
	-20	8.8	81		V.46- 6- 1	0.0	74
	V.13-27- 2	5.3	90		- 2	9.0	88
	V.13-29- 5	3.5	76		- 5	4.8	73
	-11	11.1	74		- 8	9.4	75
	V.46- 1- 1	15.6	76		-20	5.9	73
	- 3	12.3	85		V.46-15- 2	5.0	73
	- 6	8.1	72		- 3	3.6	72
	-20	1.9	71		- 6	8.3	73
	V.46- 2- 1	3.6	75		V.46-16- 1	3.7	95
	- 3	7.1	76		- 2	10.7	75
	- 4	5.6	82		- 3	9.1	73
	- 6	3.4	75		-11	3.9	78

At the appearance of the first flower, observations were recorded for node number, "shedding" and "budding" for 686 plants in Plot A and 830 plants in Plot B. Correlations were worked out between "shedding" and "budding" with the following results:—

TABLE V.

Plot.	Correlation.	Probability.
A	-19±.04	Less than .01
B	-.05±.03	.20

From these results it appears that "shedding," up to the time of first flower, has no significant relation to "budding" and this can be explained on the assumption that "shedding" acts as a stimulus in promoting the elongation of the plant's main axis from which new sympodia are produced, as the food which would normally be utilised by the buds, on their being shed, is directed towards augmenting the

scaffolding of the plant as compensation for this loss. It will be seen later on in this report that a highly significant positive correlation was obtained between "budding" and "bolling." As time was a limiting factor, "bolling" was recorded in Plot A for those plants only with 4% "shedding" and under, and in Plot B for those plants with 64 "buds" and over. The following are the results put forward in frequency array form for both parents and progeny:—

TABLE VI.
FREQUENCY ARRAYS OF "SHEDDING."

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	29	45	49	n.	Mean.
Parent of Plot A	2	11	31	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50	1.82
Plot A	29	24	61	83	92	81	78	68	59	30	23	19	18	6	4	5	2	1	1	1	1	—	—	—	—	—	—	—	686	5.57
Parent of Plot B	2	2	6	10	4	2	6	1	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36	4.22
Plot B	10	30	34	62	92	90	100	72	75	69	37	41	33	8	17	14	17	10	3	2	2	3	3	2	1	1	1	1	830	7.34

TABLE VII.
FREQUENCY ARRAYS OF "BUDDING."

	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	<i>n.</i>	<i>Mean.</i>
Parent of Plot A	—	—	—	—	—	—	4	5	4	12	8	10	5	2	—	—	—	—	—	—	50	49.5
Plot A	1	4	6	6	17	35	44	54	76	89	91	90	75	41	43	11	3	—	—	—	686	49.3
Parent of Plot B	—	—	—	—	—	—	1	1	1	6	8	5	10	2	—	1	—	1	—	—	36	56.1
Plot B	1	1	3	7	6	10	29	36	62	78	101	114	132	96	76	43	17	13	4	1	830	53.9

TABLE VIII.
FREQUENCY ARRAYS OF "BOLLING."

	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	115	n.	Mean.
Parent of Plot A	—	—	1	2	3	3	4	5	3	6	8	3	9	2	—	—	1	—	—	50	58.5
Plot A	1	2	1	3	3	6	9	10	11	6	14	9	9	5	5	2	—	1	—	97	58.8
Parent of Plot B	—	—	—	—	—	—	—	—	—	—	—	7	19	4	1	4	1	—	—	36	77.1
Plot B	—	—	—	—	1	1	—	3	1	2	8	10	25	13	10	10	4	1	1	90	76.4

On comparing the frequency arrays for "shedding," "budding" and "bolling" of the parents and progeny it would appear that these characters are to a certain extent hereditary, the three highest "bollers" in each plot were therefore selected and the "selfed" seed of each will be sown in separate plots for further observation and selection.

TABLE IX.
SELECTIONS FROM PLOTS A AND B.

Plant.	No. of "Sheds."	No. of "Buds."	No. of "Bolls."	Plant.	No. of "Sheds."	No. of "Buds."	No. of "Bolls."
A.78	2	55	89	B.1526	4	67	114
A.79	2	55	99	B.1700	7	69	97
A.210	2	64	88	B.2031	12	72	100

Experiment 3. The Production of a Red Superfine Sea Island Cotton Strain.

In the course of his genetic experiments Harland found that the characters red plant body, weak petal spot, of the perennial Peruvian type—Trinidad Red Kidney—are allelomorphic to the characters green plant body, strong petal spot. Thus if red is transferred to a Sea Island plant body it is possible to maintain the purity of such a type commercially without resource to lint and seed analysis since any plant with a green plant body or a strong petal spot appearing in a commercial field must be a vicinist.

The original cross Trinidad Red Kidney $\times$ Sea Island Crinkled Dwarf was backcrossed to V.135 and the selfed seed of four backcrosses sown out in progeny rows at this Station in September 1930. Since lint length was the determining factor in selection, the experimental results are presented in the form of frequency arrays of mean maximum lint lengths.

TABLE X.
FREQUENCY ARRAYS OF MEAN MAXIMUM LINT LENGTHS OF RED SEA ISLAND STRAINS
(SINGLE PLANT ANALYSIS.)

	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	65	n.	Mean.
4 Strains grown in 1930 ...	...	...	2	1	4	6	3	6	5	12	3	8	2	3	3	1	-	-	-	-	59	50.5
6 Plants selected in 1930 ...	...	...	-	-	-	-	1	-	-	-	-	-	1	3	1	-	-	-	-	-	6	54.7
6 Strains grown in 1931 ...	...	1	3	3	5	-	1	-	5	5	16	7	10	6	5	2	2	1	-	-	72	51.9
6 Plants selected in 1931 ...	...	...	-	-	-	-	-	-	-	-	-	-	3	1	1	-	1	-	-	-	6	55.2
6 Strains grown in 1932 ...	...	...	-	-	-	-	-	-	3	3	15	20	14	20	12	14	5	6	4	2	119	55.0
9 Plants selected in 1932 ...	...	...	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	1	2	1	9	60.0

Explanation.—As mentioned above, the original material planted at this Station in 1930 was the second backcross of Trinidad Red Kidney $\times$ Sea Island. All four of the strains segregated for reds and greens and crinkleds and normals. Two green normals and four red normals were selected and planted in September 1931. The former bred true to green normal and intermediate petal spot, while three of the latter segregated for body colour, petal spot and leaf type, only one, R.14-19, breeding true to red normal. In this strain, however, the plant (R.14-19-7) with the longest mean maximum lint length had an intermediate petal spot. The six selections R.14-19-1, 3, 5, 7, 10 and 19 were planted in progeny rows in September, 1932. Only R.14-19-7 segregated for body colour and petal spot—the others breeding true for red plant body and weak petal spot. From these the following selections were made for planting in September, 1933.

TABLE XI.
RED SEA ISLAND SELECTIONS.

Strain.	Mean Max. Lint Length (mm.).	Lint Index (mg.).	Wt. of 100 seeds (mg.).	Ginning %.	Body Colour.	Corolla Spot Grade.
R.14-19- 1- 7	57.6	47	144	24.6	Red	8.0
R.14-19- 7- 7	61.0	43	135	24.2	"	5.3
- 8	65.0	41	147	21.8	"	13.3
-14	59.0	44	149	23.2	"	8.0
-19	60.6	43	145	22.8	"	5.0
-20	60.0	44	147	23.0	"	5.3
R.14-19-10- 3	57.6	48	143	25.1	"	5.0
R.14-19-19-10	59.2	43	168	20.4	"	8.0
-19	58.6	49	163	23.1	"	7.0

A striking feature of the red Sea Island strains pure for red plant body is their apparent immunity to Angular Leaf Spot, no cases having been observed for two seasons, although adjacent rows of other strains have been attacked. Other striking features are (1) the excellent germinating capacity of these strains, followed by quick and vigorous growth in the early stages, (2) their resistance to aphid and (3) their resistance to high winds.

Since of the major characters red plant body and weak petal spot are alone wanted from the perennial parent, backcrossing of the best red Sea Island plant by the best V.135 plant has been continued. A fifth backcross was made in 1932 and planted out in September 1933 for further study.

Experiment 4. To combine the Superfine Lint Length and Quality of V.135 with the High Yielding Character of Montserrat Sea Island.

As early as 1919 crosses were made at this Station between V.135 and Montserrat Sea Island, with the object of combining the lint length and quality of the former with the high yield of the latter. Apparently the system used was to select the longest linted F_1 and grow from it an F_2 from which the longest linted plant was again selected, grown and selfed and the same method of selection practised in the future generations. At that time a highly negative correlation was established by Burd between lint length and lint index.

Progeny of this cross, of unknown generation, was found at this Station in 1930. A progeny row was grown, and it was found that, apparently through continuous selfing of the longest linted plant, a strain pure for the major lint factors of V.135 had been extracted. It was decided therefore to repeat the cross and in December, 1930, the best Montserrat Sea Island strain was obtained, crossed with V.135 and the F_1 backcrossed to the Montserrat parent in 1931. Following are the results in target diagram form for the characters mean maximum lint length and lint index :—

TABLE XII.
LINT INDEX (mg.).

Lint Length (mm.).	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	67
50																				<i>I</i>			<i>P</i>	
51														<i>I</i>			<i>P</i>							
52								1																<i>I</i>
53						1							<i>I</i>	<i>I</i>										
54				1	1																			
55			1	1	2											<i>*I</i>								
56			1			2	1								<i>*I</i>									
57	<i>P</i>						1																	
58						1			2	<i>*2</i>														

F₁ plants—ordinary figures; backcross plants—italics; asterisk=selections.

As will be seen from the above, the lint lengths and lint indices of the V.135 and H.39-8 parents were 57 mm. and 43 mg. and 51 mm. and 60 mg. respectively. From the F₁ one plant (V.×H.-1) with a mean maximum lint length of 58 mm. and a lint index of 52 mg. was selected and backcrossed to H.39-8-2 which had a mean maximum lint length of 50 mm. and a lint index of 65 mg. The backcross was sown in 1932 and selfed. Single plant analysis of the selfed backcross was made for lint index only and those plants with 54 mg. and over were measured. The two plants, (V.×H.)×H-9 and (V.×H.)×H-11, combining long lint and high lint index have been selected and are being grown in progeny rows for further study.

Experiment 5. The Purification of a Good Type of Ordinary Sea Island Cotton.

As before mentioned, prior to 1930, Ordinary Sea Island cotton, derived from the original importation of Rivers seed, formed the bulk of the Island's crop. From this material Harland in the years 1915-1920 isolated many relatively pure strains. One of these—Ratho Mill Ordinary—was for many years prior to 1928 the only Ordinary strain grown commercially. In 1924, on the receipt of reports from the spinners on samples of Ordinary Sea Island strains grown at this Station, it was decided by the Cotton Officer (Burd) and the Agricultural Superintendent to replace Ratho Mill Ordinary with the strain BD which was accounted by the spinners the best of the strains sent for testing. It is surprising to note that although fifty pounds of pure BD seed was multiplied in 1924 the strain cannot be said to have reached general cultivation until 1928. It was in the year 1928 that estates started to grow both Superfine and Ordinary Sea Island strains together on the one estate, and that unfavourable

reports on the St. Vincent cotton were received from England, which led to the examination of the industry by Professors Ballou and Cheesman in 1930.

Cheesman on examining the strain BD in commercial fields and progeny rows at the Station found that impurity existed in both, to about the same extent as was found in the strain V.135. His results were corroborated by us in August, 1930, and the conclusion was reached that sufficient care had not been exercised in the progeny row work, with the result that natural crossing had occurred with other strains.

Many other strains of Ordinary Sea Island cotton, originally isolated by Harland, were found at this Station in 1930, but as V.135 was, commercially, to be used exclusively, it was decided that selection would only be practised on the best of the Ordinary strains, with the object of purifying them for their respective characters so that they would be ready at hand for multiplication and liberation should conditions ever warrant their return to commercial cultivation.

A list of characters of the Ordinary strains now being maintained in a pure state at the Station is given below :—

TABLE XIII.
MAJOR CHARACTERS OF ORDINARY STRAINS MAINTAINED IN A PURE STATE AT THE STATION—1933.

Strain	Mean Max. Lint Length (mm.).	Wt. of Seed cotton per boll (gm.).	Wt. of lint per boll (gm.).	Mean no. of seeds per boll.	Wt. of 100 seeds (mg.).	Lint Index (mg.).	Ginning %	Corolla Colour & Grade.
B.D. ...	51.0	4.34	1.13	22.7	117	48	29.1	Pale Yellow (6)
O. ...	52.8	3.09	1.01	18.1	114	55	32.5	Yellow (7)
A.N. ...	51.2	3.21	1.01	19.7	110	52	32.1	Yellow (8)
T.15 ...	48.8	3.78	1.25	19.7	123	64	34.2	Cream (2)
H.39 ...	51.4	4.34	1.37	21.6	133	68	33.8	Yellow (8)

Object of selection—B.D. High weight of seed cotton per boll.
O. High ginning % and lint length.
A.N. Resistance to "shedding," and Angular Spot.
T.15. To maintain the type Sea Island White.
H.39. To maintain the type Montserrat Sea Island.

Experiment 6. To produce Sea Island Lint on an American Upland Plant Body.

In the course of Harland's experiments to transfer the crinkled gene of Sea Island to American Upland the commercial potentialities of producing an American Upland plant with Sea Island lint suggested itself for experimentation. Consequently two selections of the backcross—(Sea Island Crinkled × Meade) × Meade were sent to this Station in 1931. These were grown as progeny rows in September, 1931; G.132 was pure for crinkled leaf and was discarded, and

only three normal leaved and two crinkled plants combining long lint and high lint index were selected from G.140. Following are the results :—

TABLE XIV.
SINGLE PLANT ANALYSIS OF G.132 AND G.140.

<i>Plant.</i>	<i>Mean Max. Lint Length (mm.).</i>	<i>Lint Index (mg.).</i>	<i>Wt. of 100 seeds (mg.).</i>	<i>Ginning %.</i>	<i>Type of Leaf.</i>	<i>Remarks.</i>
G.132 (1931)	48.2	—	—	—	Crinkled	
G.140 (1931)	50.8	—	—	—	Heterozygous Crinkled	
G.132- 1	49.4	47	166	22.1	Cr.	
— 2	44.2	43	155	21.8	Cr.	
— 3	48.8	47	159	22.4	Cr.	
— 4	44.4	40	122	24.7	Cr.	
— 5	48.8	49	161	23.3	Cr.	
G.140- 1	48.2	57	154	27.0	Cr.	
— 2	47.6	*59	190	23.7	N.	Selected
— 3	*48.0	54	188	22.3	N.	Selected
— 4	47.6	58	151	27.8	Cr.	
— 5	50.2	44	157	21.9	Cr.	
— 6	*51.8	50	168	22.9	Cr.	Selected
— 7	51.2	54	162	25.0	Cr.	
— 8	50.2	59	172	25.5	N.	Selected
— 9	*48.6	57	167	25.4	N.	
—10	48.6	56	156	26.5	Cr.	
—11	48.6	52	154	25.2	Cr.	
—12	48.8	56	172	24.5	N.	
—13	48.0	*62	160	27.9	Cr.	Selected

*=Point of Selection

The selfed seed of the five selections was grown in progeny rows in 1932. These gave the following results on bulk analysis :—

TABLE XV.
BULK ANALYSIS RESULTS OF G.140 SELECTIONS—SEASON 1932.

<i>Strain.</i>	<i>Mean Max. Lint Length (mm.).</i>	<i>Lint Index (mg.).</i>	<i>Wt. of 100 seeds (mg.).</i>	<i>Ginning %.</i>	<i>Leaf Type.</i>	
					<i>Normal.</i>	<i>Crinkled.</i>
G.140- 2	44.6	61	155	24.2	84	—
— 3	46.3	58	172	24.5	79	2
— 6	48.4	54	164	24.9	12	53
— 9	44.9	56	157	24.6	80	—
—13	46.8	58	163	24.7	11	42

After sowing the above progeny rows in 1932, a report was received from the Shirley Institute on samples of G.140 grown in 1931 and sent to the Shirley Institute in May, 1932; this report was not very encouraging and it was decided to discontinue the experiment.

It is, however, of interest to note that although the experiment to transfer Sea Island lint to an American Upland plant body has not proved wholly successful, it is yet evident that some at least of the genes for length of staple can be transferred without difficulty from Sea Island without any marked impairment of the agricultural properties of Upland.

Experiment 7. The Purification of Marie Galante and Moco Strains with the object of replacing the existing Marie Galante Strains in commercial cultivation in the Perennial-growing Grenadines.

As far as can be gathered from the available literature, the perennial type of cotton known as Marie Galante was in cultivation in St. Vincent and the Grenadines centuries ago. At the present time Carriacou, a dependency of Grenada, and three dependencies of St. Vincent, viz. Union Island, Canouan and Mayreau, are capable of growing annually 5,000, 800, 260 and 100 acres respectively. Five thousand and eight hundred acres of Marie Galante cotton are actually grown annually in the two first-named Islands, but latterly only small areas of approximately 40 and 30 acres respectively are being grown in the latter two Islands on account of low prices and scarcity of labour at harvesting time. Labour for this operation is obtained from St. Vincent or from the neighbouring Grenadines, as these two Islands are very sparsely populated.

It is perhaps hardly realised that Carriacou at present has the largest area devoted to cotton of any island in the British West Indies; its cotton industry therefore merits greater attention than unfortunately it has received.

At the present time two chief types comprise the perennial cotton in cultivation, viz. *G. barbadense* (Peruvian type) and *G. purpurascens* (Bourbon type). The Peruvian type is characterised by short, coarse lint and usually naked seeds, while the Bourbon type, known locally as Silk Cotton, which incidentally is immune to Leaf Blister Mite, has a longer and silkier staple. The former type constitutes some 15% of the crop in Carriacou, but is less common in Union Island. Hybrids of the two species are present though they tend to be sterile. For this reason the two species exist side by side with no marked degree of admixture.

It has been known for a considerable time that the quality and yield of Marie Galante cotton in these Islands is very poor, and the causes responsible for this were made the subject of a detailed report by the writer on his visit to Carriacou in January, 1931.

In February, 1933, Harland visited Carriacou and Union Island, with the result that an active programme for the replacement of Marie Galante by a better and higher yielding perennial cotton is now in progress. This programme calls for complete replacement of the existing type in the Grenadines by July, 1935. As this work is being done at two stations, viz. St. Vincent and Carriacou, it is dealt with in two sections.

WORK AT THE ST. VINCENT STATION.

Marie Galante Selection.—Apparently the first attempt to improve Marie Galante cotton by selection was made by Burd in March, 1922. He made 250 selections in Union Island, varying in mean maximum lint lengths from 22 to 50 mm., from which fifteen, ranging from 35 to 50 mm., were ultimately selected. He carried on this selection work until 1926 after which it was continued by the Superintendent of Agriculture, St. Vincent. The selections of the type locally designated Silk Cotton found at this Station in 1930 were stated to have been selfed and grown from selfed seed since 1922. The following are the results expressed as frequency arrays of the mean maximum lint lengths :—

TABLE XVI.
FREQUENCY ARRAYS OF MEAN MAXIMUM LINT LENGTHS OF MARIE GALANTE SELECTIONS.

	33	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	n.	Mean.
(1) S.P.A. of the Strains, made in Aug. 1930.	1	2	2	4	4	6	10	7	4	2	4	1	—	—	—	—	—	47	40.7
(2) These six strains selected from above.	—	—	—	—	—	—	—	—	1	1	3	1	—	—	—	—	—	6	44.7
(3) B.A. of six strains grown in 1930.	—	—	—	—	—	—	—	—	—	1	1	2	*1	—	*1	—	—	6	46.2
(4) S.P.A. of two strains selected from (3).	—	—	—	—	—	—	—	1	—	3	2	3	3	3	9	1	1	26	47.3
(5) S.P.A. of ten plants selected from (4).	—	—	—	—	—	—	—	—	—	—	—	1	1	—	6	1	1	10	48.8
(6) S.P.A. of the ten strains grown in 1931.	—	—	—	—	3	—	—	2	2	11	17	12	18	5	1	—	—	71	45.4
(7) S.P.A. of two plants selected from (6).	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	2	48.5
(8) B.A. of these plants grown in 1932.	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	2	47.5
(9) S.P.A. of one plant selected in 1932.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	50.0

S.P.A.=Single Plant Analysis, and B.A.=Bulk Analysis.

Explanation.—Forty-seven single plants were analysed in 1930 (1); of these six were selected (2) and sown out in September, 1930. A bulk analysis was made of these (3) and two strains selected (see *) for single plant analysis (4); from these, ten plants were selected (5) and grown in progeny rows in 1931. Climatic conditions were very unfavourable, causing the poor results obtained in the single plant analysis of them (6). The three with lint lengths of 39 mm. were naked-seeded. From the single plant analyses two plants were selected (7) and grown in progeny rows in 1932. A bulk analysis was made (8) and a single plant selected (9) for further purification and improvement in 1933.

The following is a list of the selections and their characters in order of date of selection. It is obvious from the following data that the present selection, M.G.1-14-10-17, is now in a relatively pure state

for major lint and seed characters; it is, however, a shy bearer, and is being retained only as a type, and for crossing with other perennial types.

TABLE XVII.
MARIE GALANTE SELECTIONS MADE OVER THE PERIOD, 1930-1933.

Year.	Strain.	Mean Max. Lint Length (mm.).	Lint Index (mg.).	Wt. of 100 seeds (mg.).	Ginning %.	Tuft Grade.	Remarks.
1930	M.G.1	43.2	37	106	25.8	5.0	
	2	44.0	37	96	27.8	6.0	
	3	45.0	25	93	21.2	4.2	
	4	45.4	27	92	22.7	3.8	
	5	45.2	33	88	27.3	4.0	
	6	46.0	35	90	28.0	6.2	
1931	M.G.1-1	48.6	38	108	25.8	5.2	
	-3	48.7	—	—	—	—	No sample.
	-9	47.0	30	80	27.4	1.6	
	-12	46.0	37	103	26.3	6.8	
	-14	50.8	32	107	22.8	4.4	
	M.G.6-4	49.3	—	—	—	—	No sample.
	-5	49.2	—	—	—	—	No sample.
	-8	49.8	33	99	25.2	5.0	
	-9	48.8	35	104	25.2	4.8	
	-11	48.8	34	97	26.2	5.0	
1932	M.G.1-14-10	49.0	34	127	21.1	5.2	
	-13	48.0	31	114	21.3	6.4	
1933	M.G.1-14-10-17	49.6	34	113	23.1	5.0	

TABLE XVIII.
BULK ANALYSIS OF THE STRAIN M.G.1-14-10 (SEASON, 1932).

Mean Max. Lint Length (mm.).	Wt. of seed cotton per boll (gm.).	Wt. of lint per boll (gm.).	Mean no. of seeds per boll.	Wt. of 100 seeds (mg.).	Lint Index (mg.).	Ginning %.
48.3	2.33	0.54	16.8	107	32	23.0

Moco Selection.—Harland in 1930 made an extensive survey of the Serido district of the state of Rio Grande do Norte, in North Brazil, where there exists a valuable cotton industry based on the type of tree cotton known as Moco. The staple from this cotton is exceptionally long and fine, and is capable of being spun to very high counts (about 136's); it is used by the trade for such purposes as the manufacture of sewing cotton, etc. In commercial characteristics it therefore falls into the fine Egyptian group. Botanically, the Moco cotton belongs to the same species (*G. purpurascens*) as the so-called "Silk Cotton" already referred to, and it flourishes under virtually identical cultural and climatic conditions. In the Serido district the rainfall is from 12 inches to 18 inches per annum, very sporadically distributed, and some of the commonest weeds are various species of cacti and acacia. Ratooning for several years is practised as in the Grenadines. It therefore seemed that the introduction of some form of Moco cotton might be of great advantage to those Islands in the West Indies where Marie Galante is now grown. Harland consequently brought a number of the finest types from Brazil; these were analysed and sown out in progeny rows at this Station in September, 1930. Seeing that the type

desired was a good yielder with lint length of about 48 mm. and clean tufted seeds, yield, length and tuft grade have been the chief characters employed in the selection.

For the sake of clarity the results of this selection work are put forward in the form of frequency arrays of mean maximum lint lengths with explanatory notes :—

TABLE XIX.
FREQUENCY ARRAYS OF MEAN MAXIMUM LINT LENGTHS OF MOCO STRAINS.
(SINGLE PLANT ANALYSIS.)

	24	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	54	55	n	Mean
(1) 4 strains received in 1930.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	4	44.8
(2) Above grown in 1930	-	-	-	-	1	-	-	-	-	-	1	1	-	-	-	1	1	1	3	5	2	-	-	1	1	-	-	-	18	44.2
(3) Above re-grown in 1931	1	1	1	3	2	1	4	2	6	4	6	7	1	6	12	6	10	14	7	11	8	6	2	1	3	3	1	1	130	41.7
(4) Plants selected from (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	10	7	5	2	1	3	3	1	-	36	47.8
(5) Selections grown in 1932	-	-	-	-	-	-	-	-	-	-	1	-	6	4	5	9	17	11	13	9	8	4	2	-	-	-	-	-	89	44.6
(6) Plants selected from (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	5	1	1	-	-	-	-	16	46.5	

Explanation.—Four selections sent to the Station in 1930 (1) were planted in September, 1930, and analysed in 1931 (2). As the germination of the original four strains, of which there was not much seed, was very poor, the few plants grown of each strain were considered insufficient for testing; a progeny row of each of the eighteen plants was therefore grown in September, 1931. These were analysed in 1932 (3) and selections made of all plants with lint lengths of 45 mm. and over (4) and tuft grades of 4.0 and over. In this manner it was hoped to eliminate all naked seeded types. Progeny rows were sown of the thirty-six selections in September, 1932. At this time it was considered that a large number of strains could be discarded on habit alone. Mr. J. B. Hutchinson, then of the Cotton Research Station, Trinidad, visited the Station for this purpose, and in collaboration with the writer discarded 25 of the 36 strains on such characters as (a) shy bearing, (b) dwarfism (c) lodging, (d) over-long lateral branches which split from the main axis, (e) scarcity of lateral branches, (f) apical bearing which made the plant top-heavy and likely to be blown over, and (g) boll size. The other eleven strains were analysed (5) and from two of these 16 plants were selected. Half of the selfed seed

of each of 15 of these was sent for progeny row trial in Carriacou, the remainder was retained, and were grown in progeny rows in September, 1933.

As regards the characters of the four types, M.1, 2, 3 and 4, originally sent to the Station, M.3 and M.4 on account of their short lint, naked seeds and bad habit of growth were discarded in 1932. Of the remaining two strains, M.2, although a good yielder, was apparently a hybrid with American Upland and on receipt of a very unfavourable spinning report on its lint it was decided to eliminate it from the experiment. Since M.1 is the only strain of importance, a list of its selected progeny with their characters is given :—

TABLE XX.

Year.	Strain.	Node. No.	Mean Max. Lint Length.	Lint Index.	Wt. of 100 seeds.	Ginning %.	Tuft Grade.
1931	M.1-1	18	46.4	38	104	26.9	—
	-2	20	46.0	Insufficient sample			
	-3	13	46.0	44	102	30.1	—
1932	M.1-1-5	21	45.6	40	103	28.0	5.2
	-6	20	47.2	39	124	23.9	7.6
	-7	23	45.8	38	107	26.3	6.8
	-8	20	46.8	31	119	20.6	7.0
	-10	23	45.2	37	116	24.2	7.4
	-12	26	45.8	39	121	24.4	7.4
	M.1-3-4	21	48.6	50	101	33.1	7.4
	-11	18	46.6	50	102	33.0	8.0
	-12	27	46.6	62	112	35.6	8.0
	M.1-1-5-8	20	47.0	29	104	21.8	6.2
	M.1-1-8-1	21	45.8	27	117	18.8	7.2
1933	-3	23	47.0	31	103	23.1	5.4
	-6	24	45.4	43	106	28.9	6.4
	-7	21	46.2	35	104	25.2	6.4
	-8	26	46.4	37	114	24.5	7.4
	-9	23	47.6	31	113	21.5	6.6
	-11	22	47.4	39	118	24.8	6.2
	-13	26	47.4	38	104	26.8	7.6
	-15	26	45.0	35	102	25.5	6.8
	-16	23	46.0	32	106	23.2	7.0
	-17	28	46.2	36	108	25.0	6.4
	-18	18	46.8	34	112	23.3	6.6
	-21	19	48.8	39	109	26.4	6.6
	-22	22	46.0	38	108	26.0	6.0
	-23	20	46.0	38	113	25.2	7.2

Samples of progeny of M.1-1-8 grown in 1932 were sent for testing to the spinners and brokers. The report from the Fine Cotton Spinners' and Doublers' Association, Ltd., can be summarised as follows :— M.1-1-8 is of similar length and fineness to Sakel, but very much weaker ; its strength must therefore be increased considerably. The brokers' report was quite favourable.

It should be noted that the weakness of the fibre of M.1-1-8 is probably due to the very wet conditions under which it has been grown in St. Vincent, and in support of this it may be mentioned that lint of M.1-1 grown in Union Island in 1931 from seed from this Station, on combing and measuring, appeared much stronger than that of the same strain grown in St. Vincent in the same year. It is hoped that this great disadvantage will be overcome when Moco is grown in the drier Grenadines.

Hybridization Work.—Crosses were made in 1931 between Moco and Marie Galante and Moco and Sea Island. The F_1 's of these crosses were backcrossed to Moco in 1932 and the backcrosses were grown in September, 1933, for study. It is interesting to record that the F_1 of Moco $\times$ Marie Galante was superior in vigour, yield and length and quality of lint to both of the parents. The F_2 's of the above crosses were also grown in September, 1933, for genetic study. The results so far obtained are put forward in the form of frequency arrays of mean maximum lint lengths of the parents and first generations.

TABLE XXI.
FREQUENCY ARRAYS OF MEAN MAXIMUM LINT LENGTHS OF THE PARENTS, AND F_1 's
OF THE CROSSES MOCO $\times$ MARIE GALANTE AND MOCO $\times$ S.I.

Strain.	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	Mean.
M.1-1-8	P																	46.8
M.G.1-14-10			P															49.0
F_1	4	1	3	2														48.3
M.2-7-7						P												52.4
V.46-1-6																	P	62.6
F_1									2	1	3	1			2	1		57.9

The M.2 strains having been discarded for reasons given above, the Moco $\times$ Sea Island cross was repeated in 1932 using M.1-1-8 as parent.

WORK AT THE CARRIACOU STATION.

Marie Galante Selection.—In Carriacou the Agricultural Instructor, Mr. F. A. Simmons, formerly Foreman of the Experiment Station, St. Vincent, selected one outstanding plant of the Bourbon type, from a commercial field in 1931. From this selection, known as C.1, a progeny row was grown in July, 1931, from which selections were made and planted in July, 1932. The cotton of these selections was analysed at this Station in 1933 with the following results:—

TABLE XXII.

Strain.	Mean Max. Lint Length. (mm.).	Wt. of seed cotton per boll (gm.).	Wt. of lint per boll. (gm.).	Mean no. of seeds per boll.	Lint Index. (mg.).	Wt. of 100 seeds. (mg.).	Ginning %.	Lint Length Range.
C.1-14	47.0	3.06	0.71	18.6	38	127	23.0	45-50
-18	48.2	2.91	0.63	18.2	35	125	21.6	43-51
-19	43.9	—	—	—	—	—	—	40-47
-23	47.3	3.07	0.70	19.7	36	120	22.8	40-52
-25	46.1	2.97	0.67	20.0	34	115	22.5	43-48
-27	43.5	3.30	0.67	23.4	28	113	20.1	39-48
-34	45.9	3.27	0.67	23.4	29	111	20.5	43-51
-36	45.8	3.50	0.73	22.1	33	126	20.8	40-51
-38	47.3	3.37	0.77	20.9	37	124	22.7	44-50
-39	46.6	3.44	0.74	22.2	33	122	21.5	40-51
-40	48.2	3.33	0.76	23.0	32	123	22.0	41-52
-43	46.4	3.34	0.76	20.5	37	126	22.7	41-50
-45	47.5	3.48	0.75	21.7	35	126	21.5	44-51
-52	46.6	3.23	0.68	20.7	33	123	21.2	38-52
-53	48.2	3.00	0.62	18.2	34	131	20.7	44-52
-59	46.3	2.96	0.65	19.3	34	120	21.9	42-51
-60	47.2	3.19	0.70	21.9	32	114	21.8	44-50
-63	46.3	3.00	0.64	20.0	32	118	21.5	40-49

A mixed sample of lint of the best four of the above, C.1-14, 18, 45 and 60, was sent for testing and valuation, together with a control sample of lint of the 1932 Carriacou Commercial crop. The mixed sample received a very good report on its spinning qualities and was valued higher than either the commercial sample or the sample of M.1-1-8 progeny grown in St. Vincent.

The programme of work now in operation at the Carriacou Station is (a) the growing of progeny rows of the fifteen sub-strains of M.1-1-8 already referred to, all plants of C.1-14 which had been selfed, and all plants between 47 and 49 mm. of the above C.1 strains with the exception of C.1-19 and C.1-38, and (b) the multiplication of all remaining seed of the progeny rows C.1-14, 18, 40, 45, 53 and 60.

Experiment 8. To Improve the Lint Length and Quality of Ishan Cotton.

The Ishan strain, a representative of *G. Barbadosense*, is the type commercially cultivated in Southern Nigeria. Its lint is short and coarse and adheres very strongly to the seed. The seed is characterised by having a huge tuft at the end opposite the hilum.

A strain of this type was sent to the Station in 1931, crossed to V.135 and the F_1 backcrossed to the Ishan parent. One hundred and sixty plants of the backcross were grown in September, 1933, to enable the inheritance of lint length, lint index and seed weight to be studied. The following are the characters of the parents used in the cross and the results obtained to date:—

TABLE XXIII.
CHARACTERS OF PARENTS AND F_1 OF THE CROSS ISHAN $\times$ V.135.

Strain.	Mean Max. Lint Length (mm.).	Wt. of seed cotton per boll (gm.).	Wt. of lint per boll (gm.).	Mean no. of seeds per boll.	Lint Index (mg.).	Wt. of 100 seeds (mg.).	Ginning %.
Ishan A-5	39.0	2.59	0.97	14.8	55	135	29.0
V.46-1-6	62.6	2.72	0.62	16.8	41	128	24.3
F_1	49.0	3.53	1.18	18.4	64	128	33.3

The Ishan parent and the F_1 were badly attacked by Angular Leaf Spot. Since Angular Leaf Spot is apparently of great importance in Nigeria, its incidence will be recorded for each plant of the backcross.

Experiment 9. Work on U.4 Cottons.

Following a visit to South Africa, experiments were undertaken by Harland at the Cotton Research Station, Trinidad, on the South African U.4 (Upland) cotton. The experiments were based on the theory that in acclimatising cottons to new areas the greater the genetic variability, the greater is the chance of finding a type suitable to any particular environment.

The following types were used in the experiment :—

- (1) A.F.-1—Cambodia, grown at Barberton, South Africa, by Parnell—completely jassid-proof.
- (2) A.F.-2—A strain of Parnell's U.4.
- (3) A.F.-3—do.
- (4) Type 24.—Jamaica Xerophytic. A hairy variety of Bourbon perennial from Jamaica.
- (5) Type 57.—An Upland with lint index 100 mg.
- (6) Gambia 14.—A prolific type allied to Bourbon—Native to the Gambia. (*G. purpurascens* var. *punctatum*.)
- (7) Galapagos 1.—A very hardy and prolific native variety from the Galapagos Islands. A representative of *G. Darwinii*.

The following crosses were made by Harland :—

- A.F.-A = Cambodia × Jamaica Xerophytic) × U.4.
 A.F.-B. = (U.4 × Jamaica Xerophytic) × Upland.
 A.F.-C. = (U.4 × Cambodia) × U.4.
 A.F.-D. = (U.4 × Gambia 14) × U.4.
 A.F.-E. = (U.4 × Gambia 14) × Cambodia.
 A.F.-F. = (Cambodia × Galapagos 1) × U.4

From each backcross ten plants were selfed and the selfed seed bulked but kept separate for each of the six backcrosses. The bulked seed was planted at the St. Vincent Station in September, 1932. Each of the six plots was attacked by aphid, red spider and angular leaf spot, but only in a few sporadic cases was there any real damage. As the attacks were general it cannot be said that any one of the plots was more susceptible than the others.

Observations were made for hairiness of each plant of the six plots. It was found that hairiness at the back of the leaf provided a fairly good indication of general hairiness of the plant body; the plants were therefore classified as follows :—

TABLE XXIV.

Grade.	Description of Grade.	A.F.-A.	A.F.-B.	A.F.-C.	A.F.-D.	A.F.-E.	A.F.-F.
0	No hair	—	1	—	1	—	—
1	Hair on leaf veins alone	5	68	—	17	4	3
2	Very slightly hairy	23	31	—	34	18	7
3	Slightly hairy	25	26	23	59	45	18
4	Fairly hairy	41	43	90	84	83	19
5	Hairy	56	33	127	82	111	11
6	Very hairy	46	27	67	22	43	2
	Totals	196	229	307	299	304	60
Mean		4.3	3.1	4.8	3.8	4.3	3.6

Each plant was selfed and the selfed seed harvested separately, but analysis for lint length, lint index, seed weight and ginning percentage was done on the hairy and very hairy plants only. The following are the results of a bulk analysis performed on each plot, and frequency arrays of lint length, lint index, seed weight and ginning percentage.

TABLE XXV.
RESULTS OF BULK ANALYSIS OF A.F.- SERIES.

Strain.	Mean Max. Lint Length (mm.).	Wt. of seed cotton per boll (gm.).	Wt. of lint per boll (gm.).	Mean no. of seeds per boll	Lint Index (mg.).	Wt. of 100 seeds (mg.).	Ginning %.
A.F.-A.	35.6	3.55	1.02	27.5	37	92	28.6
-B.	34.9	5.06	1.77	31.5	56	104	35.1
-C.	36.0	4.43	1.55	32.0	48	90	34.9
-D.	32.9	3.39	1.06	29.2	36	78	31.3
-E.	36.0	4.43	1.32	27.9	47	112	29.7
-F.	34.0	3.46	0.99	22.6	44	109	28.5

TABLE XXVI.
MEAN MAXIMUM LINT LENGTH (IN mm.).

Strain.		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	n.	Mean.	
A.F.-A.	...	...	...	...	...	...	1	5	7	11	10	16	10	18	9	10	2	102	36.5			
-B.	...	...	...	...	...	...	1	2	6	4	12	8	5	7	5	1	3	...	59	35.4		
-C.	...	...	...	...	...	...	...	4	9	18	31	26	29	27	24	15	6	2	...	191	35.8	
-D.	...	...	...	...	1	...	6	11	14	21	9	7	14	8	10	1	1	...	...	103	33.0	
-E.	...	...	...	...	...	1	2	1	1	2	19	13	23	28	22	14	11	9	2	...	149	34.9
-F.	...	...	...	...	...	...	1	3	...	3	1	...	2	1	...	...	...	...	12	33.8		

TABLE XXVII.
LINT INDEX (IN mg.).

Strain.				20	23	26	29	32	35	38	41	44	47	50	53	56	59	62	65	68	71	74	n.	Mean.	
A.F.-A.	...	...	...	...	-	-	3	5	7	15	16	18	17	8	8	2	1	-	-	-	-	-	100	40.0	
-B.	...	...	...	...	-	1	-	1	-	-	2	6	2	6	8	5	7	6	10	2	1	1	1	59	52.8
-C.	...	...	...	...	-	-	-	1	4	7	38	40	33	30	19	10	4	2	2	1	-	-	191	46.8	
-D.	...	...	...	...	1	-	6	17	23	20	22	9	1	3	-	1	-	-	-	-	-	-	103	34.4	
-E.	...	...	...	...	-	-	1	2	10	8	13	31	26	26	12	8	5	1	2	-	-	-	145	43.5	
-F.	...	...	...	...	-	-	2	-	2	2	2	2	1	-	-	-	1	-	-	-	-	-	12	40.0	

TABLE XXVIII.
WEIGHT OF 100 SEEDS (IN mg.).

Strain.	45	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	150	165	n.	Mean.
A.F.-A.	...	...	...	...	1	6	6	16	15	16	15	10	10	2	3	...	...	...	...	...	100	94.7
-B.	...	...	...	...	...	2	2	4	8	3	6	10	9	1	9	2	2	1	...	...	59	104.0
-C.	...	...	...	...	1	2	2	12	26	35	25	12	13	14	8	1	4	1	...	...	191	92.1
-D.	...	...	...	...	1	13	13	13	18	15	14	9	3	2	2	...	...	...	...	...	103	76.4
-E.	...	...	...	...	...	2	2	5	5	7	9	22	17	17	17	16	15	4	5	1	145	108.2
-F.	...	...	...	...	...	1	1	...	2	1	...	2	...	2	...	1	...	1	...	1	12	104.2

TABLE XXIX.
GINNING %.

Strain.			20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	40	41	43	n.	Mean.	
A.F.-A.	...	...	...	...	1	2	4	3	7	10	9	10	13	11	9	14	3	1	—	—	—	1	—	—	100	29.7
-B.	...	...	...	...	1	—	1	1	—	1	1	2	2	8	10	6	4	7	9	3	1	1	1	59	33.7	
-C.	...	...	...	...	—	—	—	—	—	1	5	8	3	27	37	39	32	19	13	4	1	1	1	191	33.9	
-D.	...	...	...	...	—	—	4	1	2	6	7	17	12	20	17	7	7	1	2	—	—	—	—	103	31.3	
-E.	...	...	...	...	1	1	—	1	9	12	23	26	20	16	19	9	4	4	—	—	—	—	—	145	29.3	
-F.	...	...	...	...	—	1	—	2	1	2	—	—	1	3	—	1	—	—	1	—	—	—	—	12	28.5	

The above strains having been self-fertilized twice, some of them are relatively pure; the selfed seed has accordingly been divided up and distributed for trial to the following African Stations:—

THE NUMBER OF STRAINS OF EACH SERIES DISTRIBUTED.

Station.	A.F.-A.	A.F.-B.	A.F.-C.	A.F.-D.	A.F.-E.	A.F.-F.	Total.
Barberton ...	20	20	192	20	20	—	272
S. Rhodesia ...	28	32	44	42	42	—	188
N. Rhodesia ...	28	32	43	42	42	8	195
Nigeria ...	28	32	43	42	42	—	195
Nyasaland ...	28	32	42	42	42	17	203
Swaziland ...	28	32	43	42	42	—	187
Sudan ...	28	32	42	42	42	—	186
Uganda ...	28	33	43	42	44	17	207

Experiment 10. To Determine the Relation between Lint Length and Corolla Colour in the Cross Sea Island White $\times$ V.135.

A cross was made in 1930 between Sea Island White (creamy-white corolla, 48.8 mm. lint length) and V.135 (yellow corolla, 57.2 mm. lint length). The F_1 was backcrossed to Sea Island White in 1931, and 112 plants of the backcross grown in 1932 and observations recorded on them for corolla colour and lint length. No intermediate corolla colours occurred in the backcross. The following are the results :—

TABLE XXX.

Petal Grade.	46.0	47.5	48.0	48.5	49.0	49.5	50.0	50.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0	55.0	n.	Mean.
8	—	1	4	2	5	8	7	3	12	3	3	1	4	3	1	—	57	50.5
2	3	1	2	3	10	3	2	5	7	4	3	1	3	4	1	3	55	50.6

It is obvious from these results that in this particular cross there is no relation between corolla colour and lint length.

It is of interest to note that in St. Vincent the parent (AN), from which Sea Island White mutated, has a full yellow corolla, a full corolla spot and a full leaf-callus spot, whereas Sea Island White has a creamy-white corolla, intermediate corolla spot and only a few pigmented cells in the leaf-callus. For the purpose of studying the relation between these characters the cross Sea Island White $\times$ AN was made in 1932. The F_1 has been backcrossed to Sea Island White this year and a large backcross will be grown in 1934.

Experiment 11. To Determine whether the Characters "Shedding," "Budding" and "Bolling" are Hereditary in Sea Island Cotton.

While in St. Vincent, Harland by repeated selection of "non-shedding" plants isolated strains which shed hardly any buds or bolls—even under varying climatic conditions. Notable among these were two strains—AB and AN. The latter was subsequently maintained and was found in a relatively pure state in 1930 when the Station was re-opened. It is surprising to note that the strain still retains its "non-shedding" character as will be seen from the results that follow.

It was decided to repeat this work ; observations were accordingly made in 1930 on twelve plants of each progeny row for the characters "shedding" and "budding." "Bolling" was not recorded until 1931. Considerable data have been accumulated over the three seasons, but it is proposed to record only those which are necessary to illustrate what has been attained. For clarity each character is treated in a separate section.

"Shedding."—The "shedding" of twelve plants of each of 101 strains was recorded in 1930. The mean "shed" was obtained for each strain and selection made of the seven lowest "shedders" and the two highest. Selfed seed of the four plants with lowest "shedding" of each of the seven selected low "shedding" strains, and that of the three plants with the highest "shedding" of the two selections for high "shedding," was sown out in progeny rows in 1931. Unfortunately, owing to scarcity of land, the strains could not be grown in the same plot, and this disadvantage, together with the adverse climatic conditions which were experienced, produced in certain cases unexpected results. For this reason many of the previous season's selections were discarded. From the 28 "non-shedding" and 6 high "shedding" strains grown in 1931 the best "non-shedding" and high "shedding" strains were selected, and the selfed seed of the four plants with lowest "shedding" and highest "shedding" respectively of these two strains was sown in progeny rows in September, 1932. The "non-shedding" strains (AN.) were planted at the edge of the plot and to windward of the high "shedding" strains, and the space occupied by them was at a slightly lower level than the rest of the plot, with the result that the plants at the age of five weeks suffered the full benefit of the wind and cloud-burst that occurred on the 8th October, 1932, when 4.77 inches of rain fell at the Station in the space of two hours. These factors were obviously responsible for the relatively high "shedding" of the AN. strains in 1932. Following are the results:—

TABLE XXXI.

Selections in 1930.		Selections in 1931.		Selections in 1930.		Selections in 1931.	
Strain.	Mean "Shedding" of Strain.	Strain.	Mean "Shedding" of Strain.	Strain.	Mean "Shedding" of Strain.	Strain.	Mean "Shedding" of Strain.
V.6*	5.8	V.6- 4 - 5 -22	4.8 5.5 5.3	B.D.34	3.3	B.D.34- 4 - 6 - 9 -12	8.8 8.8 8.8 6.8
V.15	1.9	V.15- 6 -10 -13 -14	7.3 6.7 4.3 4.7	AN. 2.	3.1	A.N. 2- 9 -12 -13 -14	3.8 4.0 2.7 3.0
V.21	2.1	V.21- 1 - 3 -12 -14	3.7 4.2 4.0 4.5	V.A. 2	2.0	V.A. 2- 3 - 4 - 6 -17	5.7 6.0 5.0 5.5
V.45*	6.5	V.45- 5 - 6 -10	6.0 10.5 7.5	V.H. 1	2.8	V.H. 1- 2 -13 -15 -18	7.3 7.5 6.0 6.3
B.D.28	3.1	B.D.28-1 - 2 - 3 - 6	6.2 4.2 4.2 4.2				

* High Shedding.

From the above only two strains—A.N.2-13 (low "shedding") and V.45-6 (high "shedding")—were selected, from which the four

best "non-shedding" plants of the former and the four highest "shedding" plants of the latter were planted. Following are the results :—

TABLE XXXII.

Selections made in 1930.		Selections made in 1931.		Selections made in 1932.	
Strain.	Mean "Sheds" per Strain.	Strain.	Mean "Sheds" per Strain.	Strain.	Mean "Sheds" per Strain.
A.N. 2	3.1	A.N. 2-9	3.8	A.N. 2-13-3	4.3
		-12	4.0	-6	3.1
		-13	2.7	-8	4.7
		-14	3.0	-13	3.3
V.45	6.5	V.45 -5	6.0	V.45-6-6	4.2
		-6	10.5	-7	6.2
		-10	7.5	-9	3.8
				-17	6.1

TABLE XXXIII.
MEAN "SHEDDING" OF TWO TYPES.

Strain.	1930.	1931.	1932.
A.N.	3.1	3.4	3.9
V.45	6.5	8.0	5.1

TABLE XXXIV.
FREQUENCY ARRAYS OF NUMBER OF "SHEDS" PER PLANT OF STRAINS
SELECTED FOR "NON-SHEDDING."

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	20	21	Mean.
Parents 1930	25	11	8	9	13	6	5	2	3	-	1	1	-	-	-	-	-	-	-	-	2.7
Selected 1930	24	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1
Progeny 1931	3	15	34	52	71	86	75	55	42	26	20	14	2	12	3	3	5	1	2	1	6.0
Selected 1931	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0
Progeny 1932	1	5	5	10	5	7	2	3	-	1	1	-	-	-	-	-	-	-	-	-	3.9

TABLE XXXV.
FREQUENCY ARRAYS OF NUMBER OF "SHEDS" PER PLANT OF STRAINS
SELECTED FOR HIGH "SHEDDING."

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Mean.
Parents 1930	-	2	-	1	-	4	4	2	5	2	-	-	-	-	-	-	-	-	6.1
Selected 1930	-	-	-	-	-	-	-	-	4	2	-	-	-	-	-	-	-	-	8.3
Progeny 1931	-	-	5	10	9	20	16	12	14	7	10	2	2	2	4	1	-	2	7.0
Selected 1931	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	15.5
Progeny 1932	1	6	7	2	5	2	3	4	2	2	2	2	1	1	-	-	-	-	5.1

It was observed at the end of the 1932 season in the V.135 plots that a few plants had retained their original leaves in a very green condition and were producing flowers on the apical sympodial branches, when all the other plants had shed their original leaves, were drying down from their tops and had made secondary growth from which

flowers were being produced. On examination it was found that the former mentioned plants had shed almost all of their bolls. The three plants were self-fertilized and a few selfed bolls obtained from each. The seed was planted in September, 1933, for observation.

"*Budding*."—"Budding" was also recorded for twelve plants of each of the 101 progeny rows grown in 1930. The mean "budding" per strain was obtained and selection made of the six strains with the highest means. The selfed seed of the three plants of each of these six strains with the highest "budding" per plant was grown in 1931. From the eighteen selections only one strain (V.30-3) with the highest mean "budding" was selected and the selfed seed of the two plants with the highest "budding" per plant of this strain was grown in 1932. As mentioned in the former section, the adverse climatic conditions in 1931 and 1932 are responsible to a great extent for the difference in the results of the parents and progeny.

As before only relevant records are presented :—

TABLE XXXVI.

Selections in 1930.		Selections in 1931.		Selections in 1930.		Selections in 1931.	
Strain.	Mean "Budding" of strain.	Strain.	Mean "Budding" of strain.	Strain.	Mean "Budding" of strain.	Strain.	Mean "Budding" of strain.
V.30	68	V.30-3	56	Gx.12(3)	56	Gx.12(3)-8	46
		-4	45			-9	40
		-10	54			-11	47
V.35	66	V.35-1	49	B.D.23	51	B.D.23-3	48
		-2	47			-8	43
		-4	49			-10	54
Z. 2	53	Z. 2-2	49	B.D.26	52	B.D.26-2	45
		-17	49			-7	45
		-21	44			-8	43

TABLE XXXVII.

Selections made in 1930.		Selections made in 1931.		Selections made in 1932.	
Strain.	Mean "Buds" per strain.	Strain.	Mean "Buds" per strain.	Strain.	Mean "Buds" per strain.
V.30	*68	V.30-3	56	V.30-3-1	57
				-2	60

* In 1930 "budding" was not recorded until twenty days after the plants selected for "budding" observations had flowered, thus making the figures for this year much higher than they should be.

TABLE XXXVIII.

FREQUENCY ARRAYS OF NUMBER OF "BUDS" PER PLANT OF THE V.30 STRAINS.

	39	42	45	48	51	54	57	60	63	66	69	72	75	78	n.	Mean
Progeny of V.30 grown 1930	...	...	...	...	...	1	1	2	1	1	1	3	1	10	68	
Selections V.30-3, -4, -10	...	...	...	...	...	...	...	...	...	...	...	2	1	3	76	
Progeny of V.30-3, -4, -10	...	1	1	3	2	5	1	4	1	...	...	...	...	18	51	
Selections V.30-3-1, -2	...	...	...	...	...	...	...	2	...	...	...	...	...	2	60	
Progeny of V.30-3-1, -2	...	...	...	...	1	2	3	5	4	2	1	2	...	20	58	

"*Bolling*."—"Bolling" was not recorded until 1931; selections were made in that year and planted in 1932. Following are the results in frequency array form:—

TABLE XXXIX.
FREQUENCY ARRAYS OF NUMBER OF "BOLLS" PER PLANT.

					25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	Mean.
Plants 1931	...	...	...	...	3	8	15	25	14	24	17	33	20	22	18	18	10	6	9	5	—	6	1	1	62.0
Selected 1931	...	...	...	...	—	—	—	—	—	—	—	—	—	—	—	2	1	1	2	1	3	2	—	—	96.7
Progeny 1932	...	...	...	...	—	—	—	1	4	3	5	10	8	20	20	13	6	5	2	2	1	—	—	—	71.8

TABLE XL.
CORRELATIONS.

Characters correlated.					Population.	Correlation.	"P."
"Shedding" of Parents in 1930 and Progeny in 1931	...	...	...	...	52	$+35 \pm .12$	$> .01$
"Budding" " " 1931 " " 1932	...	...	...	...	30	$+ .04 \pm .19$	c.80
" " " " 1930 " " 1931	...	...	...	...	52	$-.14 \pm .14$	c.30
" " " " 1931 " " 1932	...	...	...	...	30	$-.27 \pm .17$	c.10
"Bolling" " " 1931 " " 1932	...	...	...	...	30	$-.36 \pm .16$	c.05
"Shedding" and "Budding" in 1930	...	...	...	...	591	$-.37 \pm .04$	$> .01$
" " " " 1931	...	...	...	...	309	$-.14 \pm .06$	c.02
" " " " 1932	...	...	...	...	350	$-.01 \pm .05$	c.40
" " " "Bolling" 1931	...	...	...	...	309	$-.31 \pm .05$	$> .01$
" " " " 1932	...	...	...	...	350	$-.06 \pm .05$	c.30
"Budding" " " 1931	...	...	...	...	309	$+ .62 \pm .04$	$> .01$
" " " " 1932	...	...	...	...	350	$+ .45 \pm .04$	$> .01$

Discussion.—With the exception of the results obtained from "budding" and "bolling," nothing of significance can be deduced from the correlation values obtained. The reason is obvious, and it is surprising that the correlation between "budding" and "bolling" should be so significant, when it is considered that (a) the experiment was not laid out for statistical treatment, with the result that environment has affected the results to a marked extent causing in almost every case too high a standard deviation and too high a standard error, (b) in the case of values for parents and progeny the two groups were grown under totally different soil and climatic conditions—being grown in different seasons and in different plots, and (c) the date on which observations are recorded for any particular character is not constant, e.g., "shedding" and "budding" records are taken on the day the plant produces its first flower so that should a plant have shed all of the buds that would normally burst first its record for "shedding" and "budding" is not taken until a flower is produced, which may not take place until weeks after the opening of the first formed buds of other plants in the same experiment. "Shedding" and "budding" records of these plants, which have produced their first flower at various dates, are still compared. Since the environment of a late flowerer must be different from that of an earlier flowerer with regard to the time at which records for "shedding" and "budding" are taken, it is apparent that these records are not strictly comparable. The same argument holds for "bolling."

To surmount this difficulty, the observations to be taken next season in Experiment 2 will be recorded for plants of the same age and for each character on the same day, thus all "shedding" and "budding" observations will be taken on the day flowering begins in the experiment and "bolling" observations on the day boll-splitting begins. The results will then be comparable so far as age of plant and environment are concerned.

It is considered that until the results of next season's observations are available the evidence presented is not reliable enough for conclusions to be formulated.

Experiment 12. To determine how long cotton seed will maintain its viability in cold storage.

The value of this experiment can be realised when it is considered that should it be possible to keep cotton seed for any lengthy period without reducing its viability to any great extent, a supply of pure seed of any commercial strain could always be available should the commercial crop in cultivation become contaminated in any way.

Ten pounds of V.135 seed, harvested in January—March, 1932, were cleaned and a germination test taken on the 8th April, 1932, from which 95 per cent. germination was obtained. The seed was divided in half and put into two similar paper bags, one of which was hung in the office and the other hung in a room at the Government Cold Storage Plant, on the 8th April, 1932. In St. Vincent the average room temperature is about 80°F. and the temperature of the room used at the Cold Storage Plant varied from 45°–50° F., but was usually maintained at 45° F. After storing for six months germination tests were taken monthly of each lot of seed. Following are the results:—

TABLE XLI.

Date Tested.	Age in months.	Germination of seed stored at 80° F.							Germination of seed stored at 45° F.						
		10th	11th	12th	13th	14th	15th	Total.	9th	10th	11th	12th	13th	14th	Total.
8. 4.32	—	—	—	—	—	—	—	95	—	—	—	—	—	—	95
8.10.32	6	10	60	20	1	1	—	92	—	2	36	48	11	1	98
8.11.32	7	30	57	8	1	1	1	98	—	9	70	13	2	—	94
8.12.32	8	24	68	3	—	—	—	95	4	45	42	2	—	—	93
8. 1.33	9	22	64	5	2	—	—	93	—	38	40	2	—	—	80
8. 2.33	10	48	27	7	1	—	—	83	—	45	11	5	4	—	65
8. 3.33	11	35	5	3	—	—	—	*43	—	17	12	2	—	—	31
8. 4.33	12	3	66	11	2	—	—	82	—	—	2	18	2	1	23
8. 5.33	13	1	54	16	9	3	1	84	—	—	12	4	1	—	17
8. 6.33	14	28	17	8	6	1	—	60	—	1	2	2	2	—	7

* Tap water was used in the petri dish and mould fungi and bacteria developed rapidly causing the seeds to rot.

It is suggested that the poor germination of the cold storage seed can be attributed to either or both of the following causes: the presence of moisture in the parcel of seed, as at ten months the surface of the seeds developed a rich growth of mould 24 hours after removal

from cold storage, and the temperature not being kept constant. The experiment is being repeated using a temperature of 28° F. for the seed kept in cold storage.

GENERAL.

Pests.—Pink Bollworm, Cotton Stainers, Chinch Bugs, Aphis, a species of Tingid, Bronze Beetle, Red Spider, Mole Crickets, Slugs and on rare occasions Cotton Leaf Worms are met with in varying quantities every season in St. Vincent.

In the Grenadines the chief pest is the Cotton Leaf Worm (*Alabama argillacea*), which almost every year visits these Islands, often defoliating the entire cotton crops.

In the years under review, apparently as a result of the control measures, but also owing to a great extent to the change of the planting season in 1929 from June to September, the commercial crops with only rare exceptions have been particularly free of Pink Bollworm, Cotton Stainer and Cotton Leaf Worm. At the Station, however, in the 1932–33 season Cotton Stainers appeared in fairly large quantities and remained throughout the season, although large numbers were hand-collected daily. It is considered that these pests originated from the Government cotton ginnery which is separated from the Station by only a public road. Owing to several causes, which have been made the subject of a report from this Station to the Commissioner of Agriculture for the West Indies, there is really no true close season for cotton observed at the ginnery ; in support of this statement Cotton Stainers in fairly large numbers were observed by the writer in the ginnery grounds as late as the end of August 1933 when the cotton “close season” had been in operation since the 1st May.

In 1931 the period of the cotton close season was increased, as a result of suggestions put forward by this Station, from two months (1st July to 31st August) to four months (1st May to 31st August) and this change, together with recent suggestions made by this Station if adopted, should do much towards the control of pests— particularly Pink Bollworm and Cotton Stainers.

At the Station, Mole Crickets, slugs and aphis are responsible almost every year for a fair amount of damage to the seedlings, often necessitating much supplying of blank holes. Slaked lime dust circled around the plant is particularly effective against the two former pests, while aphis is completely controlled by spraying with Derrisol.

In general it can be stated that damage from pests in St. Vincent for the three seasons 1930 to 1933, has been negligible.

Diseases.—In the 1930 season a few plants at the Station died as a result of a wilt. On examination of the roots, nodules containing nematodes were observed. It is suggested that the disease was saprophytic and that the organism was of the species *Heterodera radicumicola*. The loss was not serious and the disease has never recurred.

Since the change of the planting season in 1929, diseases such as Angular Leaf Spot, Internal Boll Disease and External Boll Disease have caused little or no damage to the commercial crops.

The incidence of Angular Leaf Spot is recorded every season at the Station and, with the exception of the Moco strains, Ishan and thehy brid Ishan $\times$ V.135, the strains can be regarded as being highly resistant, particularly the Red Sea Island strains which appear to be completely immune. It has been found by repeated selection of resistant plants that strains highly resistant to Angular Leaf Spot can be produced.

Internal Boll Disease only made itself felt at the Station in 1933, and then only in the Moco strains. This can be attributed to (a) the late maturing of the bolls of perennial strains and (b) the large quantity of Cotton Stainers present.

External Boll Disease has only occurred at the Station when boll-ripening has taken place under very wet conditions. Bolls are seldom attacked unless, after splitting, they are incapable of further opening owing to high humidity. Again, in the early stages, during very wet weather, the old flower does not drop away from the young boll and acts as a medium for the growth of the fungus spores.

As an experiment, in 1931, all the furrows at the Station were forked at frequent intervals from the date of flowering to the date of boll-bursting with the object of removing any surplus moisture that had collected. Not a single case of External Boll Disease was observed throughout this season.

Climatology.—The annual rainfall at the Station ranges from 90 to 100 inches—the daily temperature ranges from 77° to 82° F. with a general mean of about 80° F. and the average degree of humidity (saturation 100) is 74. Although the cotton plots at the Station are well protected with *Gliricidia* wind-breaks, almost every season staking has to be done to prevent the plants from being blown over by wind. Damage from wind is usually experienced in the month of October.

The heaviest daily rainfall for the period under review was 4.77 inches on the 8th October, 1932, but it is not uncommon to have daily falls of two to three inches in the months of October and November. The rainfall table for the period under review is given below. The fall

is recorded under monthly totals only, as it has no direct relation to any experiment.

TABLE XLII.
RAINFALL AT THE EXPERIMENT STATION IN INCHES.

<i>Month.</i>	<i>Season 1930-31.</i>	<i>Season 1931-32.</i>	<i>Season 1932-33.</i>	<i>Mean.</i>
September ...	7.38	8.56	7.98	7.97
October ...	9.29	14.82	12.06	12.06
November ...	7.63	14.75	11.95	11.44
December ...	3.54	5.45	14.45	7.81
January ...	5.44	4.48	6.86	5.59
February ...	1.43	3.26	4.13	2.94
March ...	2.37	3.46	2.95	2.93
April ...	3.53	2.98	3.18	3.23
May ...	5.30	6.61	6.58	6.16
June ...	10.85	12.32	13.10	12.09
July ...	13.24	8.03	16.49	12.59
August ...	10.03	10.00	10.66	10.23
Totals ...	80.03	94.72	110.39	95.04

The above table shows that it was almost impossible in St. Vincent to harvest clean, dry cotton when seed was sown in June.

VISITS.

In January, 1931, Carriacou was visited at the request of the Grenada Government who had asked for a report on the cotton industry there. In the same year one-day visits were paid to most of the St. Vincent Grenadines.

In June and July, 1931, seven weeks were spent in St. Kitts and Montserrat for the purposes of (a) studying the methods of cotton selection in the former Island and (b) reporting on the purity of the St. Kitts and Montserrat commercial cotton crops. The report on this visit was submitted to the Empire Cotton Growing Corporation and to the Commissioner of Agriculture for the West Indies.

In 1932 seven weeks were spent in June and July at the Cotton Research Station, Trinidad, primarily to study literature which was not available in St. Vincent and also to become familiar with the technique employed in the work of the Genetics Department of the Station. This Station contains a rare collection of cotton types and the opportunity of studying at close quarters representative types of almost every cultivated and wild species of cotton greatly added to the value of this visit.

STAFF.

The assisting staff at the Station consists of a Laboratory and a Field Assistant. These two officers, particularly the former, deserve praise for the hard and conscientious work they have done.

FIJI

REPORT OF THE COTTON EXPERIMENT STATION, SIGATOKA, FOR THE SEASON 1932-33.

SUMMARY OF RESULTS

BY

R. R. ANSON.

The season has been one of extremes ; torrential rains fell during the months of March and April, causing many landslips, and in the Sigatoka District, all flat lands, except those situated at the head of the river, were flooded. However, the months July to October have been exceptionally dry, less than three inches having been recorded since July, but, notwithstanding this, the rainfall for the year is 10.98 inches above the average.

Nearly 60% of cotton plants on the Experimental Station died from the effects of flood. Fortunately a number of the increase plots of backcross selections, in addition to those grown on the Station, were set out on Fijian Agricultural Centres, which, being situated much higher up the river, were not very seriously damaged by flood.

The respective yields per acre from these plots are :—

<i>Type.</i>	<i>Centre.</i>	<i>Yield per Acre.</i>	<i>Area Acres.</i>	<i>Remarks.</i>
172	Sawene	1,261 lbs.	1.9	Not touched by flood
35	Bemana	713 „	5.0	About 12% washed out
63	Qalimare	672 „	2.5	Shed badly after flood
127	Votulailai	605 „	2.5	20% washed out by flood

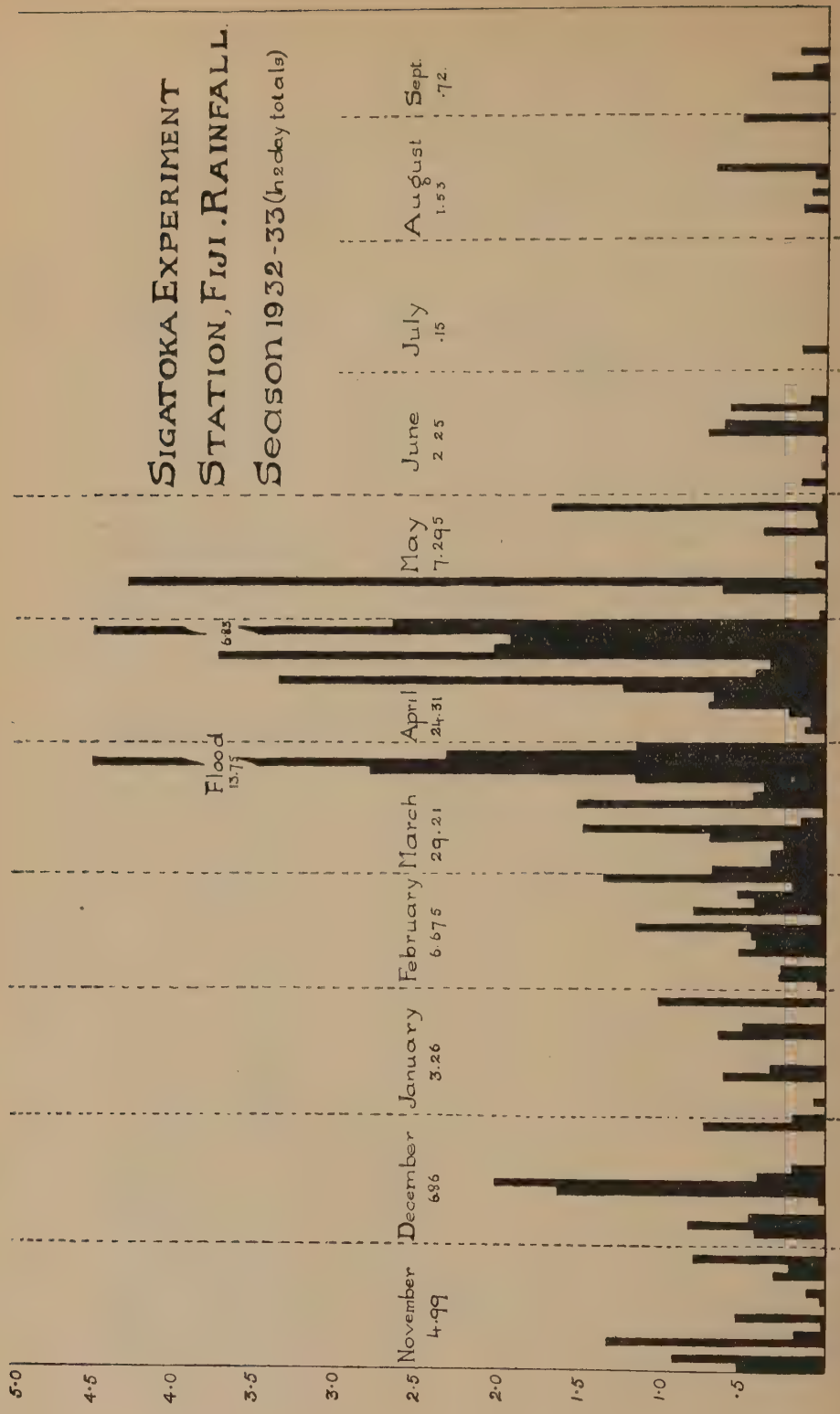
Small samples from three different types were sent to the Shirley Institute for favour of spinning test reports, and of these No. 127 showed most promise. Two bales, each containing all the types from families K3×S5 and K3×S1 were also sent ; these were found to be unsatisfactory for strength, colour and nep, but the report has been of great assistance in that it has emphasized the weak points of the variety, and it is hoped that samples going forward this season from definite types will show a marked improvement in at least two, if not all, these qualities.

The annual agricultural show for Fijians was held at the Cotton Station on 7th October. The attendance was smaller than last year, though in quality exhibits were excellent. The show was opened by the Secretary for Native Affairs and prizes were distributed by the District Commissioner. About 30 Europeans and between 150 and 200 natives were present.

The agricultural instructional scheme for Fijians progresses favourably, and a scheme for independent farm settlement has been suggested which it is hoped to commence shortly.

As stated in last year's Report, the Government decided last year to discontinue the growing of cotton commercially during the present season and to issue seed from the Cotton Experiment Station to a few isolated growers only, for multiplication purposes. Seed for planting next season has been applied for by over 1,000 growers (Indians and Fijians), and should the Legislative Council decide to continue with the cotton growing policy in Fiji, it is intended to plant 400 acres with backcross and 600 acres with Sea Island.

SIGATOKA EXPERIMENT STATION, FIJI. RAINFALL. Season 1932-33 (h₂ day totals)



EMPIRE COTTON GROWING CORPORATION

Millbank House, 2 Wood Street, Millbank, London, S.W.1.

List of Publications issued to date, to be obtained direct from the Corporation at the above address.

- "Cotton Growing within the British Empire and The World's Capacity for Consuming Cotton Goods." J. W. McConnel. 1921. Price 2s., post free.
- "Cotton Growing in Nigeria." Sir Hector Duff. Price 2s., post free.
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- * "Cotton Cultivation in Nyasaland." H. C. Sampson. 1922.
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- * "Cotton Growing within the British Empire." L. G. Killby. 1924.
- "A Cotton Research Station for the British Empire." Professor J. B. Farmer and Mr. L. G. Killby. 1925. Price 2s., post free.
- "Report on the Cotton-Growing Industry in Uganda, Kenya and the Mwanza District of Tanganyika." Col. C. N. French. 1925. Price 1s. 3d., post free.
- "Reports received from Experiment Stations for the Seasons 1923, 1924, and (South Africa only) 1925." Price 2s., post free.
- "Memorandum by the Mechanical Transport Sub-Committee." Mr. G. H. Baillie, Mr. R. H. Brackenbury, Col. C. N. French. 1925. Price 2s., post free.
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- * "Reports from Turkestan Plant Breeding Station, Tashkent." 1928.
- "Review of the Situation in the Principal Cotton-Growing Territories of the Empire, and a Summary of the Main Activities of the Corporation since their Formation." 1928. Price 6d., postage extra.
- "Report on Cotton Breeding and Seed Supply in Nigeria, 1928." F. L. Engledow and C. N. French. Price 2s., post free.
- * "Memoirs of the Cotton Research Station, Trinidad." Series B. Physiology. No. 1. Studies on the Transport of Carbohydrates in the Cotton Plant. Parts I. and II. T. G. Mason and E. J. Maskell. 1928.

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List of Publications—Continued.

- *“ Reports received from Experiment Stations, 1927-28.”
- “ Memoirs of the Cotton Research Station, Trinidad.” Series A. Genetics.
No. 1. The Inheritance of (i) Petal Spot, (ii) Pollen Colour, (iii) Corolla
Colour. S. C. Harland. 1929. Price **2s. 6d.** post free.
- “ Reports received from Experiment Stations, 1928-29.” Price **2s. 6d.**, post free.
- “ Memoirs of the Cotton Research Station, Trinidad.” Series B. Physiology.
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Price **2s. 6d.**, post free.
- “ Memoirs of the Cotton Research Station, Trinidad.” Series B. Physiology.
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- *“ Reports received from Experiment Stations, 1929-30.”
- “ Memoirs of the Cotton Research Station, Trinidad.” Series A. Genetics.
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- “ Reports received from Experiment Stations, 1930-31.” Price **2s. 6d.**,
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in Asiatic Cottons produced by Complementary Factors. J. B.
Hutchinson. 1932. Price **2s. 6d.**, post free.
- “ Memoirs of the Cotton Research Station, Trinidad.” Series A. Genetics.
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- “ Memoirs of the Cotton Research Station, Trinidad.” Series B. Physi-
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